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The Relationship between Habitat Variables and the Distribution of the Creek Chub, Semotilus atromaculatus, and the Hornyhead Chub, Nocomis biguttatus, In Sandy, Salmon, and Northrup Creeks, Monroe County, New York

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THE RELATIONSHIP BETWEEN HABITAT VARIABLES AND THE DISTRIBUTION OF THE CREEK CHUB, *Semotilus atromaculatus*, AND THE HORNYHEAD CHUB, *Nocomis biguttatus*, IN SANDY, SALMON, AND NORTHRUP CREEKS, MONROE COUNTY, NEW YORK

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THESIS DEFENSE

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ABSTRACT

The creek chub, *Semotilus atromaculatus*, and the hornyhead chub, *Nocomis biguttatus*, along with numerous other minnow (Family Cyprinidae) species, are found in streams throughout Monroe County. Interestingly, however, only creek chubs have been found in Salmon Creek, only hornyhead chubs have been found in Sandy Creek, and both chubs have been found in parts of Northrup Creek. A review of the life history of these species suggests that differences in width of stream, depth of stream, midstream current, and edge of stream current may account for this distribution. In this study a number of habitat parameters were measured at various sites within all three of the streams. The resulting data suggests that differences in midstream and edge of stream current may account for the differing distribution of creek chubs and hornyhead chubs among streams.

BIOGRAPHICAL SKETCH

Brian P. Burke is 29 years of age and lives in Greece, New York with his wife, Melissa, and his son, Peter. He graduated from the Aquinas Institute, Rochester, New York in 1988. In 1992 Brian received a Bachelor of Arts degree in Biology from Canisius College, Buffalo, New York. From 1992 until 1994 Brian was a science and health teacher at Notre Dame High School, Batavia, New York. He has been employed in a number of different capacities while pursuing his graduate studies at the State University of New York, College at Brockport. Brian's long-term goal is to become a senior environmental scientist with an environmental consulting firm.

Dedicated to my Dad, Peter Anthony Burke

Because

He Always Believed in Me

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INTRODUCTION

Minnows (Family Cyprinidae) are important bait and prey fishes throughout North America and much of the world. New York State is home to 48 species and 52 recognizable forms of minnows (Smith 1985). The hornyhead chub, *Nocomis biguttatus*, and the creek chub, *Semotilus atromaculatus* (Figure 1), are two minnow species common to the Lake Ontario drainage system, but these two species are rarely found in the same streams in the Rochester and Brockport area (Michelson 1993). A close look at the life histories of these two species provides potential explanations for this observation.

Physical Habitat Conditions

The hornyhead chub is counter-shaded with a dark olive body and a pale yellow to white belly. They are identifiable by the dark bars at the base of their scales and their dark basicaudal (i.e., at the base of the caudal fin) spot. Breeding males have a scarlet postocular spot, a prominent middorsal stripe, and 40 to 60 tubercles on their heads between the nares and the occiput and sometimes on the nape (Lachner 1952, Scott and Crossman 1971).

The hornyhead chub is a moderately distributed Mississippi refugium species (Lachner and Jenkins 1971). They occur in cool streams with gravel substrates from southern Canada south to Arkansas and from the Mohawk river in New York west to North Dakota (Scott and Crossman 1973). Habitats vary within this geographic range, but some generalizations can be made.

The hornyhead chub prefers small to moderate sized streams and tributaries with moderate to low gradients. They are uncommon in streams with shifting sand or silt, preferring gravel and rubble substrate with some sand. Optimum water conditions are clear with moderate flow and some plant growth. Riffles and pools are commonly present, with young hornyhead chubs found in pools providing plant cover and having little to no current. Optimum summer water temperatures in New York range from 21 to 27 °C (Lachner 1950, Lachner 1952, Lachner and Jenkins 1971).

The creek chub, like the hornyhead, is counter-shaded with an olive green body, silvery sides and a silvery-white belly. Creek chubs have a dark spot at the anterior base of their dorsal fins. Breeding males have 6 to 10 tubercles on each side of the head (Scott and Crossman 1973, Carlander 1969, Smith 1985).

The creek chub is widely distributed in moderate sized streams from southern Canada south to northern Florida and from eastern Texas to the Atlantic coast (Scott and Crossman 1973). This large geographic distribution has resulted in numerous studies on the habitat of the creek chub. McMahon (1982) used the results of these studies to create a habitat suitability index model for the creek chub that is representative of its wide range.

The ideal habitat for creek chubs is clear, cool streams with gravel substrate and well-defined riffles and pools. Their abundance is greatest in streams with gradients from 7 to 13.4 m/km, although they have been found in streams with gradients of 3 to 23 m/km. Streams 0.5 to 7 m wide and less than 1 m deep are preferred. Streams greater than 2 m deep or 12 m wide are considered marginal habitats. Creek chubs survive best in a pH range of 6.0 to 9.0 (McMahon 1982, Moshenko and Gee 1973). The upper lethal temperature for creek chubs is near 32 °C (depending on acclimation) while the lower lethal is about 1.7 °C. Growth occurs from 12 to 24 °C with optimum growth occurring around 21°C (Moshenko and Gee 1973). Creek chubs can survive short periods at dissolved oxygen levels as low as 2.4 mg/L, but 5 mg/L and above is considered ideal (Starrett 1950, McMahon 1982).

Nests are built in fast, shallow channels (30 - 60 cm/sec) and this is where young creek chubs are generally found. Juveniles are found in intermediate channels and pools (15 - 30 cm/sec) while adults are generally found in deep, slow-moving pools (<15 cm/sec) (Moshenko and Gee 1973).

<u>Reproductive Habitat and Behavior</u>

Both of these chubs are benthic non-guarders, i.e., there is no guarding of the nest by either parent once spawning is completed. Males build large pebble nests in which eggs are laid and fertilized. Breeding tubercles (present in males of both species) are probably important in preventing abrasions from nest building activities and from agonistic encounters during spawning (Lachner 1952).

Creek chubs begin to spawn in the spring when daytime temperatures reach 14 °C and above. In upstate New York and southern Canada spawning begins in late May to early June. In Illinois spawning may begin in April and in Iowa it occurs as early as March. Fecundity varies with female size and ranges from 1150 to 7550 eggs/female (Moshenko and Gee 1973, Carlander 1969).

Reighard (1910) performed a thorough study of the spawning habits of the creek chub. Spawning begins when the male begins building a nest, usually above a riffle. The male creates a depression in the substrate by vigorously swimming against the bottom and carrying stones upstream. As eggs are deposited in the resulting pit, the male covers them with stones and enlarges the pit further downstream. The gravel ridge formed is anywhere from 0.5 to 2 m long, 0.25 m wide, and 5 cm high (Moshenko and Gee 1973, Scott and Crossman 1973, Reighard 1910).

Breeding male creek chubs are often found in association with common shiners, *Notropis cornutus*. These shiners attempt to enter the nest and are usually chased away. However, if the shiners give the chub enough space to work on his nest (generally an area 50-100 mm around the chub) they can use the nest for their own spawning. Subordinate male creek chubs may also use a dominant male's nest in this way (Miller 1964).

Spawning occurs when a female approaches the pit of the nest. The male rises up from the bottom and grasps her with his pectoral fins. The female releases about 50 eggs which are fertilized and deposited into the nest. This whole process takes less than one second. The male then begins covering the eggs and the female swims off to mate again. Females continue to spawn for a number of days until all eggs are released (Reighard 1910).

Spawning of hornyhead chubs also begins in the spring when water temperatures reach about 18 °C. In upstate New York this occurs in late May to early June (Scott and Crossman 1973). Spawning habits are remarkably similar to those of the creek chub.

Spawning begins when a male builds a nest, usually below a riffle (Dalton 1987). The male creates a depression by rapidly swimming against the substrate, as does the creek chub, and pebbles are placed in the depression to form a large dome. These nests may contain up to 10,000 pebbles and rise 50 to 150 mm above the substrate. Fecundity ranges from 460 to 725 eggs/female (Lachner 1952, Smith 1985).

The following cyprinids have been associated with, or are known to spawn in the nests of hornyhead chubs: common shiner, rosyface shiner (*Notropis rubellus*), southern redbelly dace (*Phoxinus erythrogaster*), central stoneroller (*Campostoma anomalum*), and blackside darter (*Percina maculata*; Lachner 1952). The hornyhead may exhibit agonistic behavior towards these fishes, but generally an interesting mutualism exists between the common shiner and the hornyhead. The chub builds the nest which is used by both minnows, and the shiner chases away intruders. This breeding habit lends itself to hybridization but there is no evidence of hybridization occurring (Lachner 1952).

Spawning occurs when a female approaches or is driven over a nest by a male. The female deposits the eggs in the nest and the male fertilizes them and covers them with pebbles. The female swims off to spawn again. It is estimated that as many as ten females may spawn at a single nesting site (Lachner 1952, Dalton 1987).

Life History and Development

Growth in both the creek chub and the hornyhead chub is rapid from birth to reproductive maturity, and seasonal fluctuations in growth rates occur. Hornyheads tend to develop faster and are shorter-lived than creek chubs.

Very little information is available on the early development of the hornyhead chub. The time from spawning to hatching is unrecorded, but by the end of their first year hornyhead chubs are 20 to 50 mm in length. Males grow faster than females, attaining a mean length of 123 mm at age 3 compared to a mean length of 106 mm for females (Lachner 1952). Seasonal fluctuations in growth rates occur and are caused by seasonal variations in temperature. Maximum standard lengths are about 124 mm for males and 118 mm for females, although larger hornyheads (170 mm standard length) have been captured (Lachner 1952).

Both male and female hornyhead chubs reach sexual maturity at age 3 and die soon after spawning (Lachner and Jenkins 1967, Lachner 1950). Of 401 specimens caught by Lachner (1952) in the Lake Ontario drainage system, only one female had reached age 4 and only 6 males and 34 females had reached age 3. Lachner suggests that individuals in this population were fast growing (reaching 90 to 100 mm in length), reached sexual maturity by age 2, and that most of that year class did not live to a third summer.

The creek chub is a longer-lived species, generally living 6 to 7 years. Males reach sexual maturity in their fourth year while females are mature by their third (Smith 1985). Growth is rapid; young creek chubs can grow 20 to 25 mm from July to August in Iowa (Dinsmore 1962). Growth tapers off after spawning; males attain a maximum length of 305 mm and females attain a maximum length of 279 mm (Moshenko and Gee 1973). Size of creek chubs varies with geographic location, but upstate New York populations follow the pattern described above (Smith 1985).

Overall, the creek chub grows larger and matures more slowly than the hornyhead chub. Creek chubs have the potential to be iteroparous (spawning more than once in a lifetime; Moshenko and Gee 1973, Scott and Crossman 1973, Reighard 1910, Smith 1985), while it appears that hornyhead chubs are semelparous (spawning only once in a lifetime; Lachner and Jenkins 1967, Lachner 1950).

Diet

Both the creek chub and the hornyhead chub have a diet that changes throughout the life cycle. Young of the year and juveniles tend to have different diets than adults in both species. This limits competition between age classes for food and thus allows for better recruitment into each population when the age classes (within one species) are sympatric (Barber and Minckley 1971, Moshenko and Gee 1973, Lachner 1950).

Young creek chubs (age 1, 20-40 mm in length) are dependent mostly on insects (both aquatic and terrestrial) and their larvae as a food source (Starrett 1950). These insects include chironomids, mayflies, caddisflies and dragonflies. Unlike older creek chubs, the diet of these young chubs does not change much during the course of the summer. Only the types of insects eaten changes based on seasonal availability (Barber and Minckley 1971, Moshenko and Gee 1973).

Juvenile creek chubs (ages 2-3, 41-80 mm in length) are more dependent on crayfish, mollusks and other fish as food sources. In late spring and early autumn these juveniles compete with the young creek chubs for available insects and insect larvae since other food sources are scarce. However, from June until September, fish such as the brook stickleback, mollusks, and crayfish make up the majority of the juvenile creek chub's diet (Starrett 1950). In this way the diets of juveniles and young of the year are separated during the peak growing season in the summer (Barber and Minckley 1971, Moshenko and Gee 1973).

Adult creek chubs (age 4+, 80+ mm in length) are even more dependent on crayfish, mollusks and other fish as a part of their diet than juvenile fish are. Adult fish only eat insects and insect larvae when other food sources are limited in late spring. The fact that the September and October diet of adult creek chubs is mostly crayfish and mollusks (Starrett 1950) suggests that these food sources are available at this time of year. Adults probably outcompete juveniles for this limited food source in the autumn, causing the juveniles to eat more insects in the fall months. Creek chubs do not appear to eat other cyprinids although they may become cannibalistic if food is in very short supply (Moshenko and Gee 1973, Barber and Minckley 1971).

Very little study has been done on the diet of the hornyhead chub. Lachner (1950) studied the stomach contents of 299 specimens collected in upstate New York. He discovered that the diet of the hornyhead chub, like that of the creek chub, changes at different life stages.

The diet of young hornyhead chubs (standard length 27-37 mm) in July is made up of approximately 30% insects (chironomid larvae and mayflies), 45% crustaceans (Cladocera), 14% mollusks, and 10% filamentous algae. By September, insects make up 89% of the young hornyhead chub's diet and crustaceans make up less than 2% (Lachner 1950).

Juvenile hornyhead chubs (standard length 38-76 mm) also have seasonal diet changes. In June, their diet consists of 72% insects (mostly chironomids), 10% crustaceans (amphipods and decapods), 9% plant material, and small numbers of mollusks and annelids. By July and August insects comprise only 63% of the diet while the level of crustaceans and mollusks rises to 22% and 10% respectively. By September insects only comprise 48% of the diet while plant material comprises 33% of the diet of juvenile hornyhead chubs (Lachner 1950).

Adult hornyhead chubs (>76 mm standard length) have a diet of 12% insects, 32% crustaceans and 56% plant materials. Changes in the diet of adult hornyhead chubs during the course of the summer have not been recorded but most likely occur based on food availability. Unlike the creek chub, the hornyhead chub never eats other fish (Lachner 1950).

The hornyhead chub and the creek chub are important prey fish in stream communities. By living sympatrically with other closely associated minnows, a good forage base can be maintained in streams (Scott and Crossman 1973, Lachner 1952). The fact that many other minnows depend on the nesting habits of the creek and hornyhead chubs for their own spawning suggests that these species are vital to the maintenance of community structure in small streams.

Study Objectives

Michelson (1993) determined that creek chubs are the predominant chub species in Salmon Creek while hornyhead chubs predominate in Sandy Creek. These streams enter Lake Ontario approximately 8 miles apart in Monroe County, New York (Figures 2 and 3). To further complicate matters, Haynes (1994,1996) found that creek chubs and hornyhead chubs live sympatrically in relatively similar numbers in Northrup Creek, which enters Lake Ontario approximately 4 miles east of Salmon Creek (Figure 4).

The central question addressed by my thesis project was: what physical habitat factors appear to prevent creek and hornyhead chubs from living sympatrically in selected western New York streams? My objectives were to: (1) identify 3 sites in each stream with the appropriate populations of chubs (i.e., only creek chubs in Salmon Creek, only hornyhead chubs in Sandy Creek, and both in Northrup Creek), (2) determine habitat conditions at these sites, and (3) compare the data from each stream with the data from the other streams. The null hypothesis was: stream habitat parameters in the study streams do not differ from each other. If habitat parameters were related to the separation of these two minnow species in Sandy Creek and Salmon Creek, then, based on my literature review, differences would be expected in the following parameters: depth, width, midstream current, and edge of stream current (Table 1). In Northrup Creek, where both species occur, these parameters would be expected to fall somewhere in between the measurements of Sandy Creek and Salmon Creek.

METHODS

Identification of Stream Sites

The first step in this project was to identify potential sites for habitat measurements in each of the three streams. Two criteria had to be met for a site to be chosen: (1) accessible by foot from the nearest road, and (2) contain only the species of chub specified by Michelson (1993) and Haynes (1994, 1996). If it was found that a site in Sandy Creek contained creek chubs or that a site in Salmon Creek contained hornyhead chubs, then there would be no question about their ability to live sympatrically and no reason to continue this project.

The first criterion was easily met by looking at a map and selecting a number of potentially accessible sites. Three sites were selected for each stream. The sites in Sandy Creek were: (1) Groth Rd. in the Town of Murray, (2) Brick Schoolhouse Rd. in the Town of Hamlin, and (3) Church Rd. in the Town of Hamlin (Figure 2). The sites in Salmon Creek were: (1) just off Salmon Creek Rd. in Northampton Park, Town of Ogden, (2) the corner of Washington St. and Ogden-Parma Townline Rd., Town of Ogden, and (3) Burritt Rd. in the Town of Hilton (Figure 3). Two sites in Northrup Creek, Town of Ogden, were chosen based on the work of Haynes (1994,1996) which suggested that they contained both species of chub. These two sites were: (1) at BOCES on Big Ridge Rd. and (2) just upstream of the sewage treatment plant off of Big Ridge Rd. The other site chosen was on Dean Rd., one mile north of Ridge Rd., Town of Parma (Route 104, Figure 4).

The second criterion required sampling of each site to determine the presence/absence of each chub species. Sites were sampled in April and May, 1998 by backpack electroshocking. The approximate number of creek chubs and hornyhead chubs caught at each site can be found in Table 2 (exact numbers were not kept once >20 of a species was found).

The site at BOCES in Northrup Creek was impassable 250 ft upstream of Big Ridge Rd. due to overhanging vegetation, therefore 250 ft was used as the standard length of each site on each stream. Each site was then subdivided into five 50 ft sections. These sections were marked at each site with string in the overhanging vegetation which was readily identifiable each time the sites were visited.

1998 Design

The 50 ft sections of each stream were numbered from 1 to 15 starting with the section furthest upstream. Five of these sections were then randomly drawn out of a hat and these sections were the sites for habitat measurement in 1998. It is important to clarify the terms 'site' and 'section' as they are used in this project. A 'site' refers to the 250' length of stream measured at three different places within a stream (e.g., Dean Rd. was a site sampled in Northrup Creek). 'Section' refers to any of the 50' distances into which each site was divided (Figures 5 and 6).

Sites were visited once per month from June to August 1998. The sections chosen (Figure 5) were: (1) Sandy Creek - Groth St. - 1 and 4, Brick Schoolhouse Rd. - 6 and 8, Church Rd. - 14, (2) Salmon Creek - Sandy Creek Rd. - 2 and 4, Ogden-Parma Townline Rd. - 8, Burritt Rd. - 11 and 14, (3) Northrup Creek - BOCES - 1 and 4, Treatment - 10, and Dean Rd. - 11 and 12. Habitat parameters collected within each section were: % pools, pool class rating, % cover, width, pH, shoreline vegetation index, primary substrate, temperature, dissolved oxygen, % shaded, and depth.

Pools are utilized as cover by creek chubs as well as hornyhead chubs. A pool is an area of the stream that has a visibly slower current than the rest of the stream (Armour et al. 1983). Percent pools was measured by a visual estimate of the entire section.

Once pools were identified they were classified in the following way. First class pools (recorded as 1) were large and deep, providing a low velocity resting area. In first class pools, greater than 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, and boulders. In second class pools (recorded as 2), 5 to 30% of the bottom was obscured. In third class pools (recorded as 3), cover was only in the form of shade or turbulence, if present. The bottom of third class pools was almost entirely visible (McMahon 1982). Pool class rating was estimated visually.

Cover is any material or condition that provides protection from predators or competitors, including organic debris, logs, rubble, overhanging vegetation within 0.3 m of the water's surface, water depth > 15 cm, and near bottom velocities < 15 cm/s (Platts 1982). Percent cover was estimated visually.

Width of the stream was measured at five separate points (approximately equidistant from each other) in each section during each month. A tape was stretched across the stream and width was estimated to the nearest inch.

Since there was 100 ft of shoreline on the banks of each section, the % of different types of vegetation along the banks was easily estimated visually or measured with a tape. A vegetation index was devised: V = [4*(% trees) + 3*(% shrubs) + 2*(%

grass) + 1*(% bare ground)], with the idea being that trees and shrubs provide better cover and bank stability than grass and bare ground.

Primary substrate type (i.e., the most common substrate type) was measured with a meter stick or visually estimated while walking through the section. The type of substrate was determined by substrate size (Table 3). Substrate types were quantified as follows: silt = 1, sand = 2, gravel = 3, cobble = 4, boulders = 5, and bedrock = 6.

Temperature and pH were measured monthly at each section using a mercury thermometer and hydrion paper, respectively. Dissolved oxygen was measured using a YSI Model 50 meter which was calibrated before each sampling session. Depth was measured to the nearest cm with a meter stick at 10 haphazardly chosen points in each section. These points were chosen anywhere within the section; no effort was made to be sure that an equal number of edge and midstream depths were taken.

The percent of a section that was shaded was measured using a spherical dome densiometer. Each month three measurements were taken approximately equidistant from each other in each section. The measurements were taken at what was visually estimated to be midstream.

A number of problems arose during collection of data in 1998. The first of these was that although dissolved oxygen should decrease as temperature increases, regression analysis of this measurement in this study suggests that this was not the case ($r^2 = 0.042$, $P>0.1$; Figure 7). Either the equipment was inoperative or improperly calibrated or operated. The second problem was that the Northampton site (Figures 3 and 5) on Salmon Creek was < 5 cm deep in the month of August, a depth in which neither species could survive. A third problem was that the monthly repetition of measurements at the same sections in 1998 was not representative of the whole 250 ft of stream at each site. A fourth problem was a disparity, due to randomization, in the number of sites for each stream type (i.e., 2 sites contained both chubs, 3 sites had hornyheads only, and 4 sites had creek chubs only). Because of these problems sampling methods were redesigned for 1999. Dissolved oxygen was removed as a measurement because of questions about the equipment and observations of rapidly flowing water in all streams that should have been close to saturation. Also removed as a measurement was pH, as it was nearly the same (pH 6-7) at every site in 1998 (Appendix A).

1999 Design

Because of the problems mentioned above, one site at each stream was eliminated from the original design. In Salmon Creek the choice was easy, the Northampton site was eliminated since it had almost dried up during the previous summer. In Sandy Creek, the site at Brick Schoolhouse Rd. was eliminated. This site is regularly used by classes at the State University of New York College at Brockport for electrofishing, so it was eliminated to remove any questions about the effects of regular electrofishing on the population of hornyhead chubs at the site. The site at Dean Rd. was eliminated from Northrup Creek because it did not contain both species of chub in 1998 as it had in earlier years (Haynes 1996, 1994). To decrease the amount of repetition of measurements at the same sections at each site, and to account for variation of sections within sites, two sections were randomly chosen at each site each month (Figure 6).

The following habitat parameters were measured monthly (from August to December 1999) at each site: % pools, pool class rating, % cover, width, shoreline vegetation index, primary substrate type, temperature, % shaded, depth, and middle and edge current velocities. All habitat parameters were measured as described for 1998.

The availability of a current meter made it possible to measure velocity in this design. Edge current was defined as the velocity of the stream within 1 meter of either bank. To determine velocity, the average of three measurements was calculated. Three different sampling locations were chosen within each section (two on one side of the stream and one on the other side). Middle current was defined as the velocity of the stream > 1 meter from either bank. Middle current velocity was measured using a current meter in the same way as edge current (see above). Three different sampling locations were chosen within each section with no predetermined distance between sampling sites. For both edge and middle current instream vegetation affected the choice of sampling sites as it interfered with the operation of the current meter.

Statistics

Although the sections sampled in the final design of this project were chosen randomly, the stream sites were chosen subjectively based on presence of one or more of the species of chub concerned and the accessibility of the site by foot. Also, only two sites were chosen in each stream. Thus, it is necessary to show that there is no difference in habitat parameters between the stream sites before these sites can be combined to compare streams as a whole. Therefore, a nested analysis of variance (Zar 1996, Underwood 1997) was used to compare each parameter among the three streams and between the sites that were nested within each stream (Appendix B). If the null hypothesis that sites within streams were the same was falsely accepted (a type II error), and the measurements of sites within a stream were then pooled for use in a subsequent single-factor ANOVA, excessive type I errors (sites within streams were different was falsely accepted) would result from the single-factor analysis (Underwood 1997). Therefore, to guard against such errors, a higher α value (α=0.25) was used for testing the hypothesis that there is no difference between a stream's sites (Underwood 1997). The null hypotheses were (1) habitat parameters within a stream did not differ between sites and (2) habitat parameters did not differ among streams.

To check for monthly variability, each habitat parameter needed to be tested for significant differences between months within each stream. Since this project was conducted over several months, certain habitat parameters (e. g., temperature) naturally varied greatly from month to month. To reduce the effects of monthly variance, the data for these parameters were ranked (Zar 1996) and the ranks used for stream comparisons. A single-factor ANOVA was used to compare months for each habitat parameter within each stream (α = 0.05, Appendix C). The null hypothesis was that monthly measurements of habitat parameters within a stream did not differ. Once the null hypothesis (i.e., no difference between months within streams) was rejected for a habitat parameter in one stream, it was unnecessary to test that parameter in the remaining streams (Appendix C).

Once the first null hypothesis (i.e., no differences between sites within streams) was accepted for the nested ANOVA and habitat measurements were ranked (if necessary, Appendix D), a single-factor ANOVA was performed on each habitat parameter (α = 0.05, Appendix E). Each section within a sampling site was chosen for habitat measurements at least once during the project; however, numerous sections were chosen more than once. To eliminate repetition of sections during analysis, the data from one month of those sections was randomly chosen to represent data from all of the months available. The null hypothesis was that habitat parameters among streams did not differ. When the null hypothesis was rejected, a Tukey test (Zar 1986) was performed to try to determine where differences occurred. The minimum detectable difference (δ) was calculated for the analysis of each habitat parameter. Assuming that s^2 (as calculated by the ANOVA) is a good estimate of σ^2, the minimum detectable difference is the smallest difference between μ's (at 90% confidence) that can be detected at a given δ and n (Zar 1996).

RESULTS

Temperature

The nested ANOVA performed on the temperature parameter found no significant difference within streams (P>0.25; Table 4). Because significant differences were found between months in Sandy Creek (P<0.0001; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found no significant difference in temperature between Sandy, Salmon, and Northrup Creeks (P=0.87; Table 6).

pH

The nested ANOVA performed on pH found no significant difference within streams (P>0.25; Table 4). The inter-stream ANOVA found no significant difference in pH between Sandy, Salmon, and Northrup Creeks (P=0.2; Table 6).

Width

The results of the nested ANOVA on the width parameter found a significant difference within streams (0.25>P>0.1; Table 4). Because differences within streams were equal to or greater than differences between streams, an inter-stream ANOVA was not performed. The results of the nested ANOVA suggest that a difference existed between streams (P<0.001; Table 6). Tukey test results showed that: (1) width was greater in Sandy Creek (46.6 ft) than in Salmon Creek (28 ft) and Northrup Creek (16.6 ft) and (2) there was no difference between Salmon Creek and Northrup Creek (Tables 7 and 8).

Depth

The nested ANOVA on the depth parameter found no significant difference between streams ($P>0.25$; Table 4). Because significant differences were found between months ($P<0.0001$; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found a significant difference in depth between Sandy, Salmon, and Northrup Creeks ($P=0.03$; Table 6). Tukey test results showed that: (1) Sandy Creek (average rank=65) was deeper than Salmon Creek (average rank=52.8) and (2) there were no differences between Sandy Creek and Northrup Creek or between Salmon Creek and Northrup Creek (Tables 7 and 8).

Middle Current

The nested ANOVA on the middle current parameter found no significant difference within streams ($P>0.25$; Table 4). Because significant differences were found between months in Salmon Creek ($P<0.0001$; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found a significant difference in middle current between Sandy, Salmon, and Northrup Creeks ($P<0.0001$; Table 6). Tukey test results showed that Salmon Creek (average rank=13.2) was slower than Northrup Creek (average rank=18.9) which was slower than Sandy Creek (average rank=24.5; Tables 7 and 8).

Edge Current

The nested ANOVA on the edge current found no significant difference between streams (P>0.25; Table 4). Because significant differences were found between months in Sandy Creek (P=0.0015; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found a significant difference in edge current between Sandy, Salmon, and Northrup Creeks (P<0.0001; Table 6). Tukey test results showed that: (1) edge current is faster in Sandy Creek (average rank=24.9) than in Salmon (average rank=14) and Northrup (average rank=19) Creeks and (2) there is no difference in edge current between Salmon and Northrup Creeks (Tables 7 and 8).

% Pools

The nested ANOVA performed on the % pools parameter found no significant difference within streams (P>0.25; Table 4). Because significant differences were found between months in Salmon Creek (P=0.0023; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found no significant difference in % pools between Sandy, Salmon, and Northrup Creeks (P=0.16; Table 6).

Pool Class Rating

The nested ANOVA performed on the pool class rating parameter found no significant difference within streams (P>0.25; Table 4). Because significant differences were found between months in Salmon Creek (P=0.026; Table 5), ranks were used for inter-stream analysis. The inter-stream ANOVA found no significant difference in pool class rating between Sandy, Salmon, and Northrup Creeks (P=0.42; Table 6).

Vegetation Index

The nested ANOVA performed on the vegetation index parameter found no significant difference within streams (P>0.25; Table 4). The inter-stream ANOVA found no significant difference in vegetation index between Sandy, Salmon, and Northrup

Creeks (P=0.42; Table 6).

% Shaded

The results of the nested ANOVA on the % shaded parameter found a significant difference within streams (0.1>P>0.05; Table 4). Because differences within streams were equal to or greater than differences between streams, an inter-stream ANOVA was not performed. The results of the nested ANOVA suggest that a difference existed between streams (P<0.05; Table 6). Tukey test results showed that: (1) % shaded was greater in Salmon Creek (77%) than in Salmon Creek (29%) and (2) there were no differences between Sandy Creek and Northrup Creek or between Sandy Creek and Salmon Creek (Tables 7 and 8).

% Cover

The results of the nested ANOVA on the % cover parameter found a significant difference within streams (0.25>P>0.1; Table 4). Because differences within streams were equal to or greater than differences between streams, an inter-stream ANOVA was not performed. The nested ANOVA results also suggest that a difference exists between streams (P<0.025; Table 6). Tukey test results showed that: (1) % cover was greater in Northrup Creek (45%) than in Salmon Creek (11%) and (2) there were no differences between Sandy and Salmon Creeks or between Sandy and Northrup Creeks (Tables 7 and 8).

Primary Substrate Type

The nested ANOVA on the primary substrate type parameter found no significant difference within streams (P>0.25; Table 4). The inter-stream ANOVA found a significant difference in primary substrate type between Sandy, Salmon, and Northrup

Creeks (P=0.001; Table 6). Tukey test results showed that: (1) primary substrate was larger in Sandy Creek (3.7, gravel/cobble) and in Salmon Creek (4.3, cobble/boulder) than in Northrup Creek (2.1, sand) and (2) there was no difference between Sandy and Salmon Creeks (Tables 7 and 8).

DISCUSSION

If habitat parameters are related to the allopatry of creek and hornyhead chubs in Sandy Creek and Salmon Creek, then differences would be expected in one or more of the parameters listed in Table 1. The differences observed in my study were in depth, width, % shaded, % cover, primary substrate type, midstream current, and edge of stream current (Table 7). No differences among streams were found in temperature, vegetation index, pool class rating, pH, and % pools (Table 6). These results can be related to the occurrence of creek chubs and hornyhead chubs in my study streams.

Temperature, pH and pool class rating were all expected to be similar between Sandy and Salmon Creeks because both chubs require similar conditions for these parameters (Table 1). Thus it is not surprising that no differences were found among the three streams. The minimum detectable difference (Table 6) suggests that these streams are very similar for pH (δ=0.64, or less than 1 pH unit). The minimum detectable differences for pool class rating (δ=3.71 out of 12 total ranks) and temperature (δ=5.25 out of 12 total ranks) are large and show that the tests for those parameters were not very powerful. However, it is reasonable to conclude that pH, temperature, and pool class rating are similar in Sandy, Salmon, and Northrup Creeks and do not influence the allopatry of creek and hornyhead chubs.

Width was expected to be significantly different between these streams as hornyhead chubs are reported to prefer wider streams than do creek chubs (Table 1). The results of the nested ANOVA and Tukey tests (Tables 6, 7 and 8) suggest that Sandy Creek is in fact significantly wider than both Salmon and Northrup Creeks suggesting that this parameter is related to the allopatry of creek and hornyhead chubs in Salmon and Sandy Creeks.

If depth was related to the allopatry of hornyhead and creek chubs in Sandy and Salmon Creeks then depth was expected to be different in the two streams because creek chubs are reported to prefer slower moving pools and hornyhead chubs are often found in shallower and faster moving riffles (Table 1). The mean depth in Sandy Creek was greater than in Salmon Creek (Tables 6, 7 and 8) which provides evidence that this habitat parameter is related to the allopatry of creek and hornyhead chubs in these streams. Surprisingly, however, it appears that depth is greater in streams with hornyhead chubs than in streams with creek chubs (Table 8). It was expected that the reverse would be true (Table 1). That expectation, however, was an educated guess based on a very limited number of studies done on the life history of the hornyhead chub (Lachner 1950, 1952, Lachner and Jenkins 1967, 1971, Dalton 1987, Smith 1985). Again, the depth of Northrup Creek, where the two chubs are sympatric, falls between the depths of the other two streams (Table 8).

Midstream and edge of stream currents appear to be significant factors in the separation of creek and hornyhead chubs between Salmon and Sandy Creeks, respectively. The fact that the mean value of both of these velocities in Northrup Creek falls between those of Sandy and Salmon Creeks (Table 8) may explain why Northrup

Creek is suitable for both species of chub. Both middle current and edge current velocity were expected to be faster in Sandy Creek than in Salmon Creek if these parameters were related to the allopatry of hornyhead and creek chubs, respectively, in those two streams (Table 1). Inter-stream analysis provides evidence that differences in current velocity exist between Sandy and Salmon Creeks (Tables 6, 7 and 8). For middle current, velocity was different ($P<0.0001$) in all three streams; while for edge current, there were differences ($P<0.0001$) between Sandy and Salmon and Sandy and Northrup Creeks (Tables 6, 7 and 8). In sum, midstream and edge of stream current velocities were faster in Sandy Creek than in Salmon Creek, and the current velocity of Northrup Creek fell between that of the other two streams in both cases.

It was unclear how % pools and vegetation index were expected to compare between Sandy and Salmon Creeks if they were related to the allopatry of hornyhead and creek chubs in those two streams, respectively (Table 1). For each of these parameters no statistical difference was found among the three streams. The minimum detectable differences suggest that these streams are very similar for vegetation index ($\delta=0.54$; Table 6); the minimum detectable difference is that of detecting the difference between ½ of a vegetation index value (1=bare ground, 2=grass, 3=shrubs, 4=trees). For % pools ($\delta=5.05$ out of 12 total ranks) the minimum detectable difference is large and suggests that the test for % pools was not very powerful. However, it is reasonable to conclude that % pools and vegetation index are similar in Sandy, Salmon, and Northrup Creeks and do not influence the allopatry of creek and hornyhead chubs.

The relationship of the % shaded and % cover parameters to the allopatry of hornyhead and creek chubs in Sandy and Salmon Creeks was unclear because little data is available concerning the requirements of the hornyhead chub for these parameters (Table 1). If hornyhead chubs prefer wider streams than creek chubs (as found above) then, perhaps, the % shaded parameter would be lower in streams containing hornyhead chubs than in streams containing creek chubs as the overhanging vegetation provides less shade in a wider stream than in a narrower stream. The results of this study support this hypothesis as Salmon Creek was more shaded than Northrup Creek (Tables 6, 7, and 8). However, the town of Ogden did clear cut the vegetation along the banks of the BOCES site in Northrup Creek between 1998 and 1999 that may have skewed these results. For the % cover parameter, Northrup Creek had more cover than Salmon Creek (Tables 6, 7, and 8). These results, combined with the presence of only creek chubs (Table 2) at the Dean Road site in Northrup Creek (where the % shaded parameter was high and the % cover parameter was low, Table 9), suggest that the % shaded parameter is important to the presence of creek chubs while the % cover parameter is important to the presence of hornyhead chubs.

Surprisingly, primary substrate type was significantly different between Sandy and Salmon vs. Northrup Creeks but not between Sandy and Salmon Creeks (Table 7). This is surprising because both the creek chub and the hornyhead chub prefer gravel substrates (Table 1). However, I question the validity of this data based on methodology (visual estimation) and the number of samples taken per site (n=1). The minimum detectable difference (δ) is 1.96 for substrate or, in other words, the difference between cobble (4) and sand (2). A larger sample size or, perhaps, a different method for quantifying substrate size would probably show no statistical difference in primary substrate size between these streams.

CONCLUSION

If the allopatry of hornyhead and creek chubs in Sandy and Salmon Creeks, respectively, is related to habitat parameters, my study indicates that differences in midstream current, edge of stream current, depth, width, substrate type, % shaded and % cover are the cause. Each of these differences can be related to the life history of the respective chub:

1. Starrett (1950) suggests that creek chubs gradually move from the fast headwaters of creeks as young to slower moving pools as juveniles and adults. Lachner and Jenkins (1971) suggest that the opposite occurs during the life of the hornyhead chub. Since electroshocking (the method of collection used in this study) is biased towards larger fish, it would be expected that the creek chubs would be found in slower moving water than the hornyhead chubs in this study, and that this difference would be significant if it contributed to the allopatry of these fishes. This is in fact the case. Juveniles were collected during electroshocking (albeit in smaller numbers than adults) but juveniles of one chub species were never found sympatrically with adults of the other chub species in Salmon Creek or Sandy Creek. This suggests that although juvenile creek chubs and adult hornyhead chubs and adult creek chubs and juvenile hornyhead chubs may prefer similar current velocities, these chubs are not found sympatrically in Salmon Creek and Sandy Creek in pool or riffle habitats. Factors other than current velocity may be responsible for the observed allopatry of different life stages of the hornyhead chub and creek chub (see below).

2. At first glance, it would appear that the hornyhead chub prefers wider and shallower streams than the creek chub (McMahon 1982, Starrett 1950), since the creek

chub prefers deep, slow-moving pools in narrow streams. Width was clearly greater in Sandy Creek than Salmon Creek, a factor that may have contributed to allopatry in the two study streams, although the test was not very powerful ($\delta = 22.65$ ft). For depth, however, the opposite was true, Sandy Creek was deeper than Salmon Creek. This suggests that other factors (e.g., stream velocity) may be more important than depth.

3. Substrate size was unexpectedly different in the study streams. Methodology (visual estimation) and small sample size (n=1 per site per month) are most likely the reason for this difference, however. The minimum detectable difference (δ) is 1.96 for substrate or, in other words, the difference between cobble (4) and sand (2). A larger sample size or, perhaps, a different method for quantifying substrate size would probably show no statistical difference in primary substrate size between these streams.

4. McMahon (1982) suggests that % shaded is important for adult and juvenile creek chub habitat while Lachner (1952) suggests that instream cover (e.g. rocks, vegetation, logs) is important habitat for prey of the hornyhead chub. The presence of both hornyhead and creek chubs at the BOCES and Sewage Treatment Plant sites in Northrup Creek (where % cover is the highest among the three study streams and % shaded is intermediate, Tables 6, 7 and 8) and the absence of hornyhead chubs at the Dean Road site in Northrup Creek (where % shaded is high but % cover is low, Table 9) suggests that the % shaded parameter is important to the presence of creek chubs while the % cover parameter is important to the presence of hornyhead chubs.

Although other factors, such as food availability, may contribute, it is relatively clear that the allopatry of creek and hornyhead chubs in the study streams is related to habitat parameters. This is especially indicated by the fact that Northrup Creek, with both species of chubs, has habitat conditions intermediate, except for % shaded and % cover, between Sandy Creek (hornyhead chubs only) and Salmon Creek (creek chubs only) for each of the parameters measured.

REFERENCES

Armour, C.L., K.P. Burnham, and W.S. Platts. 1983. Field methods and statistical analyses for monitoring small salmonid streams. U.S. Fish and Wildlife Service. FWS/OBS-83/33.

Barber, W.E. and W.L. Minckley. 1971. Summer foods of the cyprinid fish *Semotilus atromaculatus*. Transactions of the American Fisheries Society 100: 283-289.

Carlander, K.D. 1969. Handbook of Freshwater Fish Biology: Life History Data on Freshwater Fishes of theUnited States and Canada. Vol. 1. Iowa State University Press, Ames, Iowa.

Dalton, K.W. 1987. Status report on the hornyhead chub, *Nocomis biguttatus*, in Canada. Committee on the Status of Endangered Wildlife in Canada.

Dinsmore, J.J. 1962. Life history of the creek chub, with emphasis on growth. Proceedings of the Iowa Academy of Science 69: 296-301.

Haynes, J.M. 1994. Stressed Stream Analysis of Northrup Creek, Monroe County, New York. State University of New York, College at Brockport.

Haynes, J.M. 1996. Stressed Stream Analysis of Northrup Creek, Monroe County, New York. State University of New York, College at Brockport.

Hynes, H.B.N. 1976. The Ecology of Running Waters. University of Toronto Press, Toronto, Canada.

Lachner, E. A. 1950. The comparative food habits of the cyprinid fishes *Nocomis biguttatus* and *Nocomis micropogon* in western New York. Journal of the Washington Academy of Sciences 40: 229-236.

Lachner, E.A. 1952. Studies of the biology of the cyprinid fishes of the chub genus *Nocomis* of the northeastern United States. American Midland Naturalist 48(2): 433-466.

Lachner, E.A. and R.E. Jenkins. 1971. Systematics, Distribution, and Evolution of the *Nocomis biguttatus* Species Group (Family Cyprinidae: Pisces) with a Description of a New Species from the Ozark Upland. Smithsonian Institution Press, Washington, D. C.

Lachner, E. A. and R. E. Jenkins. 1967. Systematics, distribution, and evolution of the chub genus *Nocomis* (Cyprinidae) in the southwestern Ohio river basin with a description of a new species. Copeia (3): 557-580.

McMahon, T.E. 1982. Habitat suitability index models: creek chub. U. S. Fish and Wildlife Service, Fort Collins, CO. FWS/OBS-82/10.4.

Michelson, C. 1993. Independent study on *Nocomis biguttatus* and *Semotilus atromaculatus*. State University of New York College at Brockport.

Miller, R.J. 1964. Behavior and ecology of some North American cyprinid fishes. American Midland Naturalist 72: 313-357.

Moshenko, R.W. and J.H. Gee. 1973. Diet, time and place of spawning, and environments occupied by creek chub (*Semotilus atromaculatus*) in the Mink River, Manitoba. Journal of the Fisheries Research Board of Canada 30: 357-362.

Platts, W.S. 1982. Methods of Evaluating Stream, Riparian, and Biotic Conditions. INT-138. U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

Reighard, J.E. 1910. Methods of studying the habits of fishes, with an account of the breeding habits of the horned dace. Bulletin of the U. S. Bureau of Fisheries 28(2): 1111-1146.

Scott W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

Smith, C.L. 1985. The Inland Fishes of New York State. New York State Department of Environmental Conservation, Albany, New York.

Starrett, W.C. 1950. Distribution of the fishes of Boone County, Iowa, with special reference to the minnows and darters. American Midland Naturalist 43: 112-127.

Underwood, A.J. 1997. Experiments in Ecology. Cambridge University Press, New York.

Zar, J.H. 1996. Biostatistical Analysis. Third edition. Prentice Hall, Upper Saddle River, New Jersey.

Table 1. Preferred habitat for the creek chub and the hornyhead chub (based on literature review). Vegetation Index = [4*(%trees)+3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible.

Parameter	**Creek Chub**	**Hornyhead Chub**
Temperature	5 to 27°C	probably similar
pH	6 - 9	probably 6 to 8
Width	0.5-7 m	somewhat wider
Depth	< 1 m	probably shallower
midstream current	10 - 65 cm/sec	probably faster
edge of stream current	0 - 25 cm/sec	probably faster
% Pools	25 - 75	??
Pool Class Rating	1 to 2	probably 1 to 2
% Vegetation (shoreline)	0.5 - 1.5	??
% Shaded	50 - 100%	??
% Cover	> 25%	??
Substrate	gravel - rubble, some sand	gravel

Table 2. Number of fish collected at each sampling site in May and June 1998.

Site	# of hornyhead chubs	# of creek chubs
Sandy Creek		
Groth Rd.	>20	0
Brick Schoolhouse Rd.	>30	0
Church Rd.	>30	0
Salmon Creek		
Salmon Creek Rd.	0	>20
Ogden-Parma Townline Rd.	0	>20
Burritt Rd.	0	>30
Northrup Creek		
BOCES	>40	>40
Treatment Plant	>50	>50
Dean Rd.	0	>20

Table 3. Size of substrate types (modified from Hynes 1976). Substrate < 1mm was considered to be silt if it was mucky and very difficult to walk in, otherwise it was considered to be sand. Solid sections of substrate that were > ½ of the total substrate in the section were considered to be bedrock.

Substrate type	Size
bedrock	> 1/2 the section
boulder	> 256 mm
cobble	64 - 256 mm
gravel	1 - 64 mm
sand	0.06 - 1 mm
silt	<0.06mm

Table 4. Results of nested ANOVAs on all measured habitat parameters ($\alpha = 0.25$). This test was conducted to determine if a statistical difference existed between sites of the same stream for each measured habitat parameter. If a difference existed for a given parameter within a stream then the data for that parameter could not be considered as representative of the stream as a whole and thus could not be used to compare streams to each other. Vegetation Index = [4*(%trees)+3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Parameter	F	F crit	P
Temperature (°C)	0.07	1.44	P>0.25
pH	0.3	1.61	P>0.25
Width (ft)	1.5	1.44	0.25>P>0.1
Depth (cm)	0.36	1.44	P>0.25
Middle current (cm/sec)	0.63	1.44	P>0.25
Edge current (cm/sec)	0.59	1.44	P>0.25
% Pools	0.08	1.44	P>0.25
Pool Class Rating	0.39	1.44	P>0.25
Vegetation Index	0.42	1.44	P>0.25
% Shaded	2.36	1.44	0.1>P>0.05
% Cover	1.52	1.44	0.25>P>0.1
Substrate (numerical rep.)	0.44	1.44	P>0.25

Table 5. Results of single-factor ANOVAs on monthly data for each stream ($\alpha = 0.05$). Since this project was conducted over several months, certain habitat parameters (e. g., temperature) varied greatly from month to month. To reduce the effects of monthly variance, the data for these parameters could be ranked and the ranks used for stream comparisons. Thus each habitat parameter was tested for significant differences between months within each stream. Once a significant difference was found in one stream, it was unnecessary to test that parameter in the remaining streams, and the data for that parameter was ranked for all streams. This test was conducted first on Sandy Creek, then Salmon Creek, and finally on Northrup Creek. Vegetation Index = [4*(%trees)+3*(%shrubs)+ 2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

		P Values	
Parameter	Sandy Creek	Salmon Creek	Northrup Creek
Temperature	<0.0001	NA	NA
pH	0.3	0.63	undefined*
Depth	<0.0001	NA	NA
Middle Current	0.6	<0.0001	NA
Edge Current	0.0015	NA	NA
% Pools	0.12	0.0023	NA
Pool Class Rating	0.53	0.026	NA
Vegetation Index	0.36	0.16	0.09
Substrate	0.11	0.87	0.2

* All pH values for Northrup Creek were the same, therefore variance=0 so P is undefined for the test (can not divide by 0); since there is no variance, it is concluded that there is no difference among months

NA - not applicable since a difference already found in another stream

Table 6. Results of single-factor ANOVAs comparing habitat parameters between streams ($\alpha = 0.05$). Since this project was conducted over several months, certain habitat parameters (e. g., temperature) varied greatly from month to month. To reduce the effects of monthly variance, the data for each month was ranked for these parameters and the ranks were used for stream comparisons. The total number of ranks is listed in parentheses under the δ value for these parameters. For those habitat parameters that had significant differences between sections of the same stream (width, % shaded, and % cover) results of the nested ANOVAs were used. Assuming that s^2 (as calculated by the ANOVA) is a good estimate of σ^2, the minimum detectable difference (δ)is the smallest difference between μ's that can be detected at a given power, α and n (power=0.9, α = 0.05, n varies depending on parameter). Vegetation Index = [4*(%trees)+ 3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Parameter	F	Fcrit	P	δ (at 90% confidence)
Temperature	0.14	3.35	0.87	5.25 (out of 12 total ranks)
pH	1.75	3.4	0.2	0.64
Width	13.82	3.89	<0.001	22.65 ft
Depth	3.61	3.03	0.03	16.42 (out of 120 total ranks)
Middle current	12.8	3.1	<0.0001	7.94 (out of 36 total ranks)
Edge current	10.38	3.1	<0.0001	8.53 (out of 36 total ranks)
% Pools	1.97	3.35	0.16	5.05 (out of 12 total ranks)
Pool Class Rating	0.91	3.35	0.42	3.71 (out of 12 total ranks)
Vegetation Index	0.88	3.35	0.42	0.54 (range is 1 to 4)
% Shaded	5.03	3.89	<0.05	47.16%
% Cover	5.31	3.89	<0.025	40.76%
Substrate	8.93	3.35	0.001	1.96 (range is 1 to 6)

Table 7. Results of Tukey test (honestly significant difference test) for those habitat parameters with significant differences between streams ($\alpha = 0.05$). q values larger that qcrit suggest a significant difference for that parameter between those two streams.

Parameter	q crit	q (Sandy v Salmon)	q (Sandy v Northrup)	q (Salmon v Northrup)
Width	3.773	5.6	9	3.42
Depth	3.31	3.74	1.3	2.44
Middle Current	3.4	7.16	3.57	3.59
Edge Current	3.4	6.44	3.46	2.97
% Shaded	3.773	3.6	3.32	6.91
% Cover	3.773	2.4	3.24	5.64
Substrate	3.53	1.58	4.2	5.78

Table 8. Mean parameter values and minimum detectable difference (δ) from inter-stream ANOVA ($\alpha = 0.05$)*. Assuming that s^2 (as calculated by the ANOVA) is a good estimate of σ^2, the minimum detectable difference (δ) is the smallest difference between μ's that can be detected at a given power, α and n (power=0.9, $\alpha = 0.05$, n varies among parameters). For those parameters that were ranked because of monthly variability, the total number of ranks is listed in parentheses under the δ value. Vegetation Index = [4*(%trees)+ 3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Parameter	Sandy	Salmon	Northrup	δ (at 90% confidence)
Temperature (ranks)	5.8	6.2	6.5	5.25 (out of 12 ranks)
pH	6.3	6.2	6	0.64
Width (ft)	46.6	28	16.6	22.65 ft
Depth (ranks)	65	52.8	60.8	16.42 (out of 120 ranks)
Middle Current (ranks)	24.5	13.2	18.9	7.94 (out of 36 ranks)
Edge Current (ranks)	24.9	14	19	8.53 (out of 36 ranks)
% Pools	6.2	5.3	8	5.05 (out of 12 ranks)
Pool Class Rating	5.4	6.8	5.9	3.71 (out of 12 ranks)
Vegetation Index	1.9	2.1	2.2	0.54 (range is 1 to 4)
% Shaded	52	77	29	47.16%
% Cover	26	11	45	40.76%
Substrate (numerical representation)	3.7	4.3	2.1	1.96 (range is 1 to 4)

*For % Shaded, % Cover, and Width, data are from the nested ANOVAs; for all other parameters, data are from single-factor ANOVAs

Table 9. Mean values for % Shaded and % Cover parameters at the Dean Rd. site in Northrup Creek in 1998.

	% Shaded	% Cover
June	15	89
July	17.5	88.5
August	14	88.3

Figure 1. Classification of creek chub and hornyhead chub

Class Osteichthyes - bony fishes: bony scales, swim bladders or lungs

Subclass Actinopterygii - ray finned fishes

Infraclass Teleostei - true bony fishes

Superorder Ostariophysi - Webberian apparatus: bones from swim bladder to inner ear

Order Cypriniformes

Family Cyprinidae - pharyngeal teeth, no teeth on jaws, 48 species in N.Y.

Genus Semotilus - flat barbel in groove above maxillary bone

Species - *Semotilus atromaculatus* (creek chub)

Genus Nocomis - large scales, terminal barbel on maxillary bone

Species - *Nocomis biguttatus* (hornyhead chub)

Figure 2. Map of sampling sites in Sandy Creek (sites are circled and labeled).

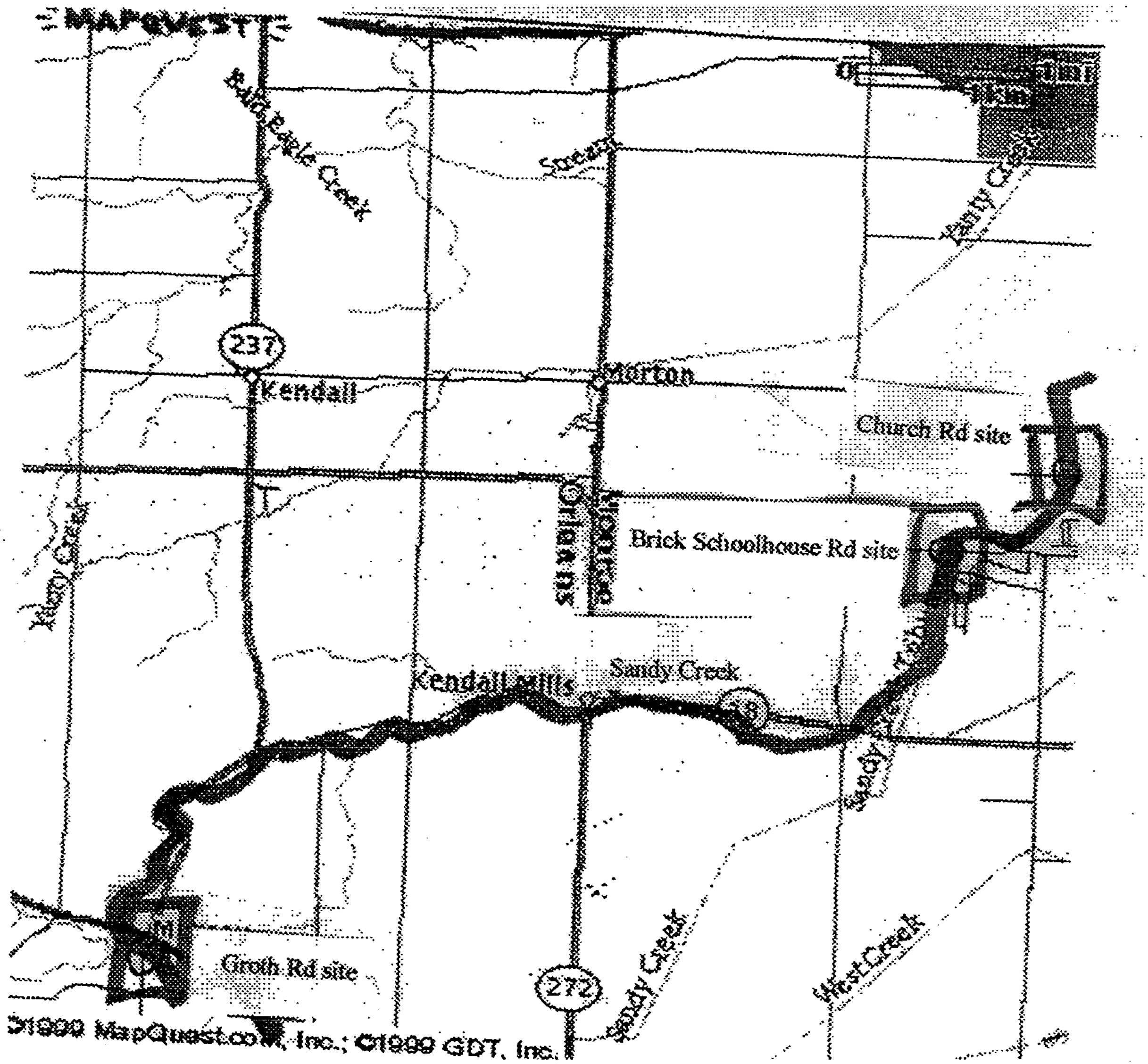

Figure 3. Map of sampling sites in Salmon Creek (sites are circled and labeled).

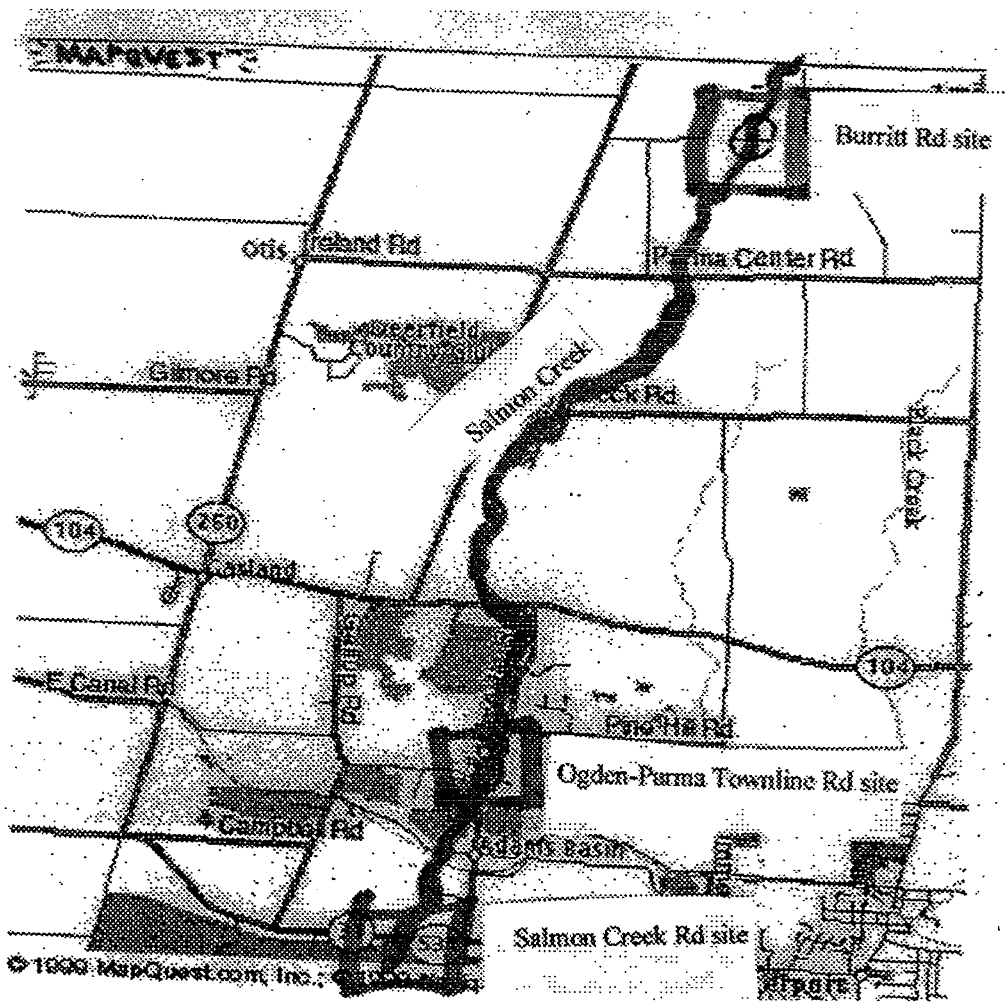

Figure 4. Map of sampling sites in Northrup Creek (sites are circled and labeled).

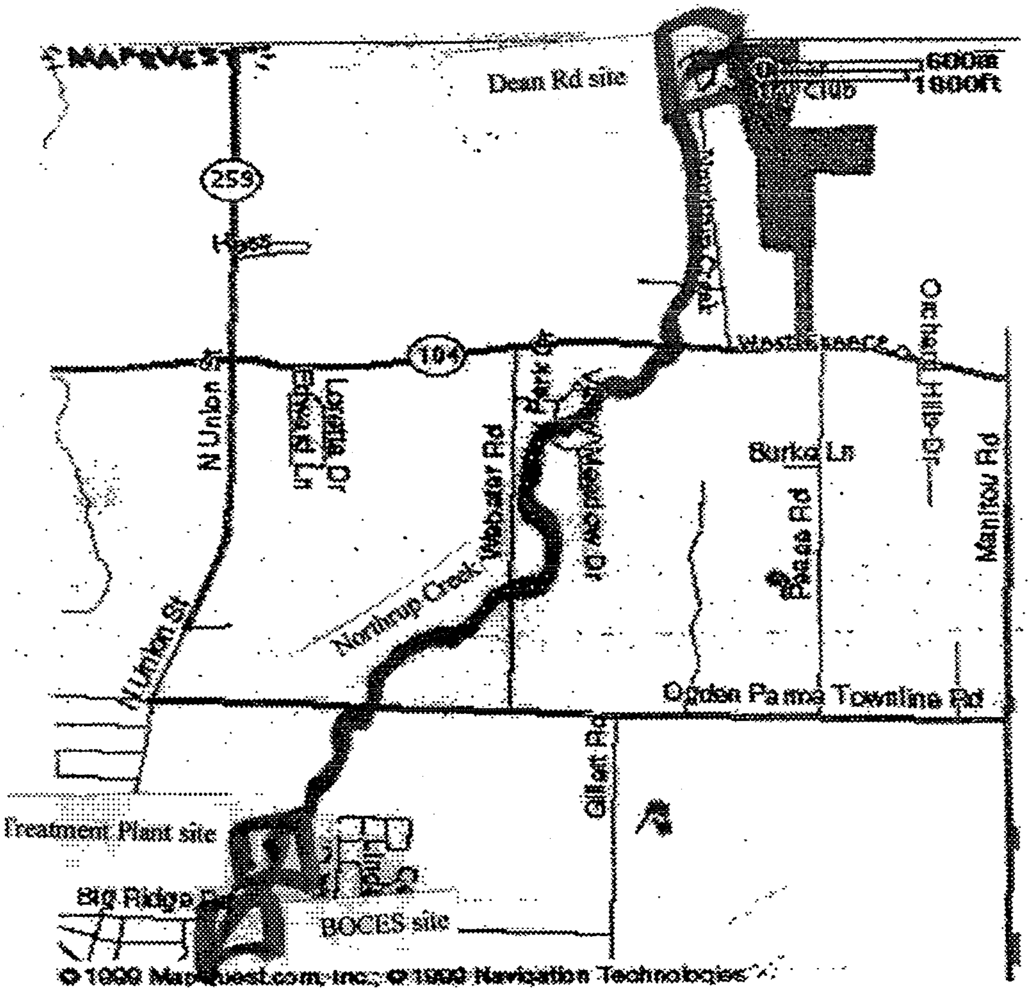

Figure 5. Sections sampled in 1998. Three sites were chosen for each stream and at each site a 250' section was measured. This site was then divided into 5 sections of 50' each that were numbered 1 to 15 (from upstream to downstream). Five of these 15 sections were then chosen at random as habitat measurement sites from June until August 1998 (sections that were sampled are in boldface).

Upstream end of each stream

	Sandy (Groth)			Salmon (Northampton)			Northrup (BOCES)	
T	**1**	50'	T	**1**	50'	T	**1**	50'
1	2		1	**2**		1	2	
250'	3		250'	3		250'	3	
1	**4**		1	**4**		1	**4**	
1	5		1	5		1	5	

	Sandy (Brick Schoolhouse)			Salmon (Ogden-Parma)			Northrup (Treatment)	
T	**6**	50'	T	6	50'	T	6	50'
1	7		1	7		1	7	
250'	**8**		250'	**8**		250'	8	
1	9		1	9		1	9	
1	10		1	10		1	**10**	

	Sandy (Church)			Salmon (Burritt)			Northrup (Dean)	
T	11	50'	T	**11**	50'	T	**11**	50'
1	12		1	12		1	**12**	
250'	13		250'	13		250'	13	
L	**14**		1	**14**		1	14	
L	15		1	15		1	15	

Downstream end of each stream

Figure 6. Sections sampled in 1999. Two sites (from the three sampled in 1998) were chosen for each stream. In Salmon Creek the Sandy Creek Rd. site was eliminated since it had almost dried up during the summer of 1998. In Sandy Creek, the site at Brick Schoolhouse Rd. was eliminated because is regularly used by classes at the State University of New York College at Brockport as an electrofishing site, raising potential questions about the effects of electrofishing on the population of hornyhead chubs at the site. The site at Dean Rd. was eliminated from Northrup Creek because it did not contain both species of chub as the other two sites in Northrup Creek did. At each site a 250' section was measured and this section was then divided into 5 sections of 50' each. These sections were numbered 1 to 5 (from upstream to downstream). Every month (from August to December, 1999) 2 sections were randomly selected from each site for measurement of habitat parameters.

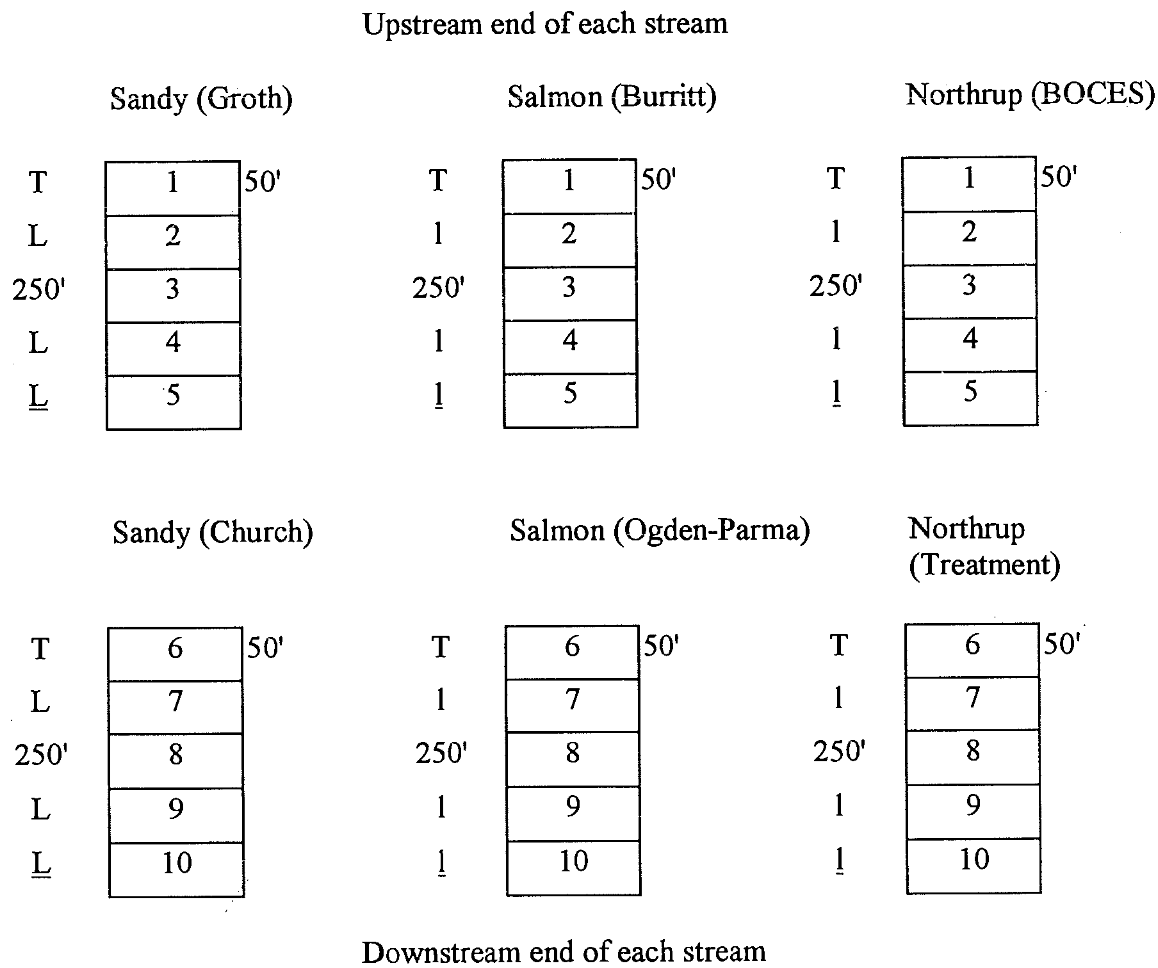

Figure 7. Regression analysis of dissolved oxygen data (from June to August 1998). A relationship should exist between temperature and dissolved oxygen (i.e., dissolved oxygen levels should decrease as water temperature increases).

Temp °C	diss oxygen
21.9	7.2
24.4	7.7
21.3	7
21.8	7.2
24.1	7.2
21.4	6.9
21.8	7.2
23.9	7.2
21.4	7
24	6.9
22.7	7
21.7	7
21.6	6.8
22.5	7
23.9	6.8
19.7	7.2
21	7.8
18.5	7.2
18.6	7.2
21.4	8.5
19.8	7
19.5	7.4
23.5	7
20.5	7.2
19.3	7
21.5	7.8
20.8	6.9
20.7	7.4
21.5	7.8
19.3	7.1
24.2	6.6
21.5	6.6
24.1	6.3
21.5	6.7
24.2	6.5
21.3	6.7
21	7
22.9	6.8
21	7
22.9	6.7

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.25846056
R Square	0.06680186
Adj R Sq	0.04224401
Std Error	0.40026147
Observations	40

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regressi	1	0.43579863	0.43579863	2.72018401	0.10733046
Residual	38	6.08795137	0.16020925		
Total	39	6.52375			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	8.49731263	0.85713515	9.9136205	4.3426E-12	6.76213317
X Variable 1	-0.0649234	0.03936429	-1.649298	0.10733046	-0.1446123

Upper 95%	*Lower 95.0%*	*Upper 95.0%*
10.23249	6.76213317	10.2324921
0.014765	-0.1446123	0.0147654

APPENDIX A: RAW DATA

The following data were collected from Sandy, Salmon, and Northrup Creeks from June until August, 1998 and from August until December, 1999. Data from June to August 1998 were used for analysis of pH since pH was not measured in 1999. Analysis of current used data from August to December 1999 only, as a current meter was not available in 1998. Analysis of all other habitat parameters used the data from June to July 1998 and from August to December 1999. Vegetation Index = [4*(%trees)+ 3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Sandy Creek, Section A1, Groth Rd. in Murray
Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				34.333						86.74	61
2				37.5						93.5	57
3				38						95.32	78
4				41.5							68
5				39							72
6											66
7											68
8											60
9											58
10						78%grass	Cobble				57
Avg/Tot	50	1	20	38.0666	7	22%bare	4	23.9	6.8	91.85333	64.5
						1.78					

Sandy Creek, Section A1, Groth Rd. in Murray
Jul-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				33.333						87.78	54
2				39						94.02	63
3				39						93.76	65
4				43							51
5				37.333							42
6											63
7											62
8											56
9											52
10						85%grass					54
Avg/Tot	25	1	20	38.3332	6	15%bare	bedrock	22.5	7	91.85333	56.2
						1.85	6				

Sandy Creek, Section A1, Groth Rd. in Murray

	Aug-98										
Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				36.667						95.06	61
2				38.5						96.36	65
3				38.667						87.14	66
4				42.417							72
5				41.833							65
6											64
7											72
8											74
9						10%tree					69
10						55%grass					67
Avg/Tot	5	2	20	39.6168	6	35%bare	sand	21.6	6.8	92.85333	67.5
						1.75	2				

Sandy Creek, Section A4, Groth Rd. in Murray
Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				42.583						91.78	45
2				44.5						85.28	48
3				40.333						64.22	50
4				42.5							50
5				43.5							58
6											55
7											50
8											50
9											51
10						80%grass	boulders				63
Avg/Tot	40	1	20	42.6832	7	20%trees	5	24	6.9	80.42667	52
						2.4					

Sandy Creek, Section A4, Groth Rd. in Murray
Jul-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				42.5						80.86	43
2				42						87.62	39
3				40.333						73.84	51
4				45.5							63
5				44.333							59
6											54
7											43
8											51
9											44
10						95%grass	boulder				50
Avg/Tot	15	1	20	42.9332	6	5%shrub	5	22.7	7	80.77333	49.7
						2.05					

Sandy Creek, Section A4, Groth Rd. in Murray

Msmt #	Aug-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				44.333						63.96	50
2				51.5						79.56	50
3				44.667						81.9	64
4				43.5							49
5				43							60
6											61
7											40
8											42
9											61
10						95%grass					65
Avg/Tot	15	1	10	45.4	6	5%shrub	sand	21.7	7	75.14	54.2
						2.05	2				

Sandy Creek, Section C14

Msmt #	Jun-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				49						26.94	17
2				47.167						28.76	28
3				48.75						23.82	25
4				47.5							24
5				55.833							53
6											57
7											52
8											34
9											54
10							cobble				30
Avg/Tot	25	1	20	49.65	6	100%grass	4	21.3	7	26.50667	37.4
						2					

Sandy Creek, Section C14

Msmt #	Jul-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				80.5						23.82	50
2				46.5						27.72	48
3				46.667						26.42	54
4				48.333							38
5				47.167							17
6											17
7											31
8											29
9											25
10						85%grass	bedrock				21
Avg/Tot	15	2	10	53.8334	7	15%shrub	6	24.4	7.7	25.98667	33
						2.15					

Sandy Creek, Section C14

Aug-98											
Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				79.75						40.46	47
2				42.5						23.04	39
3				48.333						26.42	38
4				48.167							28
5				47.5							33
6											34
7											31
8											31
9											27
10							gravel				19
Avg/Tot	10	1	10	53.25	6	100%grass	3	21.9	7.2	29.97333	32.7

2

Sandy Creek, Murray, Sec 4

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				26.75				18.98	30	0.513	0.273
2				28.25				15.08	30	0.363	0.59
3				34.75				8.06	42	0.383	0.65
4				38.333					38		
5				43.917				81.02	34		
6								84.92	31		
7					50%bare			91.94	50		
8					25%grass				45		
9					20%shrub				54		
10					5%trees				46		
Avg/Tot	10	2	5	34.4	1.8	2	15	85.96	40	0.420	0.504

Sandy Creek, Murray, Sec 5

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				27.5				7.02	65	0.317	0.417
2				25.833				3.38	54	0.227	0.403
3				23.833				16.64	43	0	0.59
4				25.417					49		
5				27.5				92.98	56		
6								96.62	53		
7								83.36	53		
8									59		
9					15%bare				49		
10					85%grass				54		
Avg/Tot	60	1	20	26.0166	1.85	2	15	90.98667	53.5	0.181	0.470

Sandy Creek, Church, Sec 3

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				47.5				73.84	48	0.16	0.353
2				47.833				84.5	50	0.033	0.39
3				47.167				83.46	45	0.06	0.52
4				47					45		
5				47.5				26.16	43		
6								15.5	25		
7								16.54	38		
8									39		
9					15%bare				41		
10					85%grass				38		
Avg/Tot	20	1	90	47.4	1.85	2	18	19.4	41.2	0.084	0.421

Sandy Creek, Church, Sec 5

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				85.583				86.32	22	0.017	0.687
2				88.583				83.98	16	0.267	0.31
3				93.25				78.78	12	0.327	0.297
4				93.583					17		
5				86.833				13.68	10		
6								16.02	19		
7								21.22	12		
8									14		
9									19		
10					100%grass				18		
Avg/Tot	5	1	90	89.5664	2	4	18	16.97333	15.9	0.204	0.431

Sandy Creek, Church Street, Sec 1

Sep-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				92.5				95.16	28	0.183	0.363
2				86.083				90.74	35	0.273	0.5
3				62.5				93.34	42	0.143	0.547
4				62.833					44		
5				52				4.84	42		
6								9.26	43		
7								6.66	26		
8									25		
9									36		
10					100%grass				38		
Avg/Tot	10	1	50	71.1832	2	3	15	6.92	35.9	0.200	0.470

Sandy Creek, Church Street, Sec 5

Sep-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				85.167				95.42	8	0.67	0.24
2				85.5				82.68	17	0.33	0.263
3				86.5				76.96	22	0.293	0.19
4				85					26		
5				82.167				4.58	27		
6								17.32	16		
7								23.04	19		
8									13		
9									19		
10					100%grass				25		
Avg/Tot	5	1	25	84.8668	2	3	15	14.98	19.2	0.431	0.231

Sandy Creek, Murray, Sec 4

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				26.583				13	29	0.427	0.557
2				25.417				10.4	37	0.17	0.543
3				23.583				6.5	35	0.143	0.597
4				27.833					39		
5				26.25				87	35		
6								89.6	57		
7								93.5	45		
8									36		
9					20%bare				45		
10					80%grass				46		
Avg/Tot	10	1	5	25.9332	1.8	5	15	90.03333	40.4	0.247	0.566

Sandy Creek, Murray, Sec 2

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				31.667				38.48	33	0.15	0.313
2				31.333				31.72	30	0.293	0.54
3				35.417				14.82	32	0.45	0.47
4				36.667					31		
5				34.167				61.52	34		
6								68.28	32		
7					50%shrub			85.18	20		
8					5%trees				25		
9					10%bare				26		
10					35%grass				12		
Avg/Tot	5	2	5	33.8502	2.5	4	15	71.66	27.5	0.298	0.441

Sandy Creek, Church, Sec 2

Oct-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				83				93.34	35	0.16	0.22
2				87.417				85.8	31	0.33	0.39
3				62.5				78.78	32	0.37	0.387
4				64.333					33		
5				56.417				6.66	33		
6								14.2	21		
7								21.22	19		
8									26		
9									47		
10					100%grass				31		
Avg/Tot	10	1	80	70.7334	2	2	9	14.02667	30.8	0.287	0.332

Sandy Creek, Church, Sec 3

Oct-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				48.167				80.34	27	0.223	0.387
2				46.75				78	30	0.267	0.223
3				46.5				73.06	40	0.277	0.487
4				46.5					39		
5				45.583				19.66	37		
6								22	38		
7								26.94	37		
8									42		
9					80%grass				44		
10					20%bare				42		
Avg/Tot	15	1	10	46.7	1.8	6	9	22.86667	37.6	0.256	0.366

Sandy Creek, Murray, Sec 2

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Oct-99										
1				32.167				10.4	29	0.13	0.447
2				32				16.9	27	0.007	0.193
3				30.417				16.64	29	0.09	0.13
4				35.333					27		
5				35.667				89.6	20		
6								83.1	27		
7					15%bare			83.36	25		
8					70%grass				23		
9					5%shrub				24		
10					10%trees				17		
Avg/Tot	3	2	2	33.1168	2.1	3	9	85.35333	24.8	0.076	0.257

Sandy Creek, Murray, Sec 5

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Oct-99										
1				29.417				11.7	60	0.277	0.533
2				31.75				6.5	51	0.193	0.667
3				38.083				2.86	54	0.167	0.443
4				39.167					57		
5				46.25				88.3	60		
6								93.5	48		
7								97.14	52		
8									61		
9					10%bare				69		
10					90%grass				56		
Avg/Tot	25	2	8	36.9334	1.9	6	9	92.98	56.8	0.212	0.548

Sandy Creek, Church Street, Sec 4

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				50.667				69.16	51	0.383	0.303
2				47.167				71.76	32	0.31	0.407
3				47.333				72.02	33	0.253	0.243
4				46.25					23		
5				46.833				30.84	29		
6								28.24	29		
7								27.98	45		
8									57		
9									52		
10					100%grass				52		
Avg/Tot	2	1	5	47.65	2	3	7	29.02	40.3	0.315	0.318

Sandy Creek, Church Street, Sec 5

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				86.667				91.26	21	0.243	0.423
2				86.167				89.7	45	0.473	0.32
3				88.167				82.16	42	0.537	0.48
4				86					21		
5				82.25				8.74	20		
6								10.3	18		
7								17.84	16		
8									28		
9									20		
10					100%grass				30		
Avg/Tot	30	1	15	85.8502	2	4	7	12.29333	26.1	0.418	0.408

Sandy Creek, Murray, Sec 1

Msmt #	Nov-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				29.833				39.78	40	0.46	0.337
2				32.5				35.1	34	0.443	0.403
3				30.417				35.62	24	0.6	0.727
4				34.417					36		
5				34				60.22	45		
6								64.9	25		
7								64.38	21		
8									40		
9					80%bare				44		
10					20%grass				39		
Avg/Tot	5	1	15	32.2334	1.2	4	7	63.16667	34.8	0.501	0.489

Sandy Creek, Murray, Sec 3

Msmt #	Nov-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				27				21.06	22	0.52	0.543
2				28.833				12.48	23	0.423	0.883
3				26.5				17.16	22	0.63	0.43
4				27.75					30		
5				30.583				78.94	26		
6								87.52	37		
7								82.84	35		
8									34		
9					25%bare				35		
10					75%grass				36		
Avg/Tot	15	1	3	28.1332	1.75	6	7	83.1	30	0.524	0.619

Sandy Creek, Murray, Sec 4

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Dec-99										
1				22.5				20.28	60	0.557	0.543
2				23.75				10.14	60	0.003	0.523
3				23.75				6.24	51	0.297	0.503
4				25.333					54		
5				26.083				79.72	45		
6								89.86	29		
7								93.76	47		
8									29		
9					45%bare				32		
10					55%grass				36		
Avg/Tot	15	1	15	24.2832	1.55	5	0	87.78	44.3	0.286	0.523

Sandy Creek, Murray, Sec 5

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Dec-99										
1				28.417				4.42	54	0	0.51
2				31.25				4.94	65	0	0.327
3				31.75				9.62	65	0.287	0.33
4				37.167					56		
5				38				95.58	52		
6								95.06	53		
7								90.38	58		
8									53		
9					10%bare				59		
10					90%grass				52		
Avg/Tot	25	1	15	33.3168	1.9	6	0	93.67333	56.7	0.096	0.389

Sandy Creek,Church, Sec 1

Msmt #	Dec-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				26.333				85.28	19	0.397	0.343
2				27				83.46	13	0.163	0.43
3				26.667				75.14	14	0.177	0.483
4				25.333					16		
5				26.167				14.72	15		
6								16.54	11		
7								24.86	17		
8									12		
9					90%grass				11		
10					10%shrub				13		
Avg/Tot	10	1	10	26.3	2.1	4	0	18.70667	14.1	0.246	0.419

Sandy Creek,Church, Sec 3

Msmt #	Dec-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				31.667				64.22	22	0.283	0.463
2				26				51.48	28	0.293	0.577
3				22.5				55.64	33	0.283	0.433
4				26					35		
5				26.75				35.78	37		
6								48.52	31		
7								44.36	26		
8									13		
9					95%grass				20		
10					5% shrubs				14		
Avg/Tot	25	1	20	26.5834	1.05	3	0	42.88667	25.9	0.286	0.491

Salmon Creek, Section B8, Ogden-Parma Rd.

Msmt #	Jun-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				18.583						96.36	22
2				21.583						85.44	27
3				25.25						82.58	23
4				26.667							23
5				26.75							24
6											15
7											20
8											18
9											19
10						40%trees					28
Avg/Tot	5	3	10	23.7666	6	60%grass	Gravel	19.5	7.4	88.12667	21.9
						1.6	3				

Salmon Creek, Section B8, Ogden-Parma Rd.

Msmt #	Jul-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				16						80.5	6
2				17						87.78	9
3				12.667						95.06	11
4				25.5							16
5				25.5							21
6											17
7											4
8											25
9											20
10						40%bare	Gravel				9
Avg/Tot	15	2	5	19.3334	7	60%grass	3	23.5	7	87.78	13.8
						1.6					

Salmon Creek, Section B8, Ogden-Parma Rd.

Msmt #	Aug-98 % Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				23						92.98	30
2				20.333						87.52	31
3				25.167						89.08	26
4				27							20
5				28							13
6											28
7											24
8											27
9						10%trees					34
10						30%bare					35
Avg/Tot	5	2	5	24.7	6	60%grass	Gravel	20.5	7.2	89.86	26.8
						1.9	3				

Salmon Creek, Section C11, Burritt Rd.

Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				33.75						47.58	38
2				31.25						81.38	48
3				33.167						92.56	48
4				30.667							50
5				27							45
6											46
7											40
8											43
9						45%bare					37
10						10%shrub	Cobble				40
Avg/Tot	5	2	5	31.1668	6	45%grass	4	19.3	7	73.84	43.5
						2.55					

Salmon Creek, Section C11, Burritt Rd.

Jul-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				23.5						54.08	23
2				24.9						78.52	32
3				29						83.72	30
4				30							32
5				32.333							26
6											29
7											25
8											31
9											28
10						10%shrub	bedrock				21
Avg/Tot	30	2	7	27.9466	6	90%grass	6	21.5	7.8	72.10667	27.7
						3.9					

Salmon Creek, Section C11, Burritt Rd.

Aug-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				32.75						86.58	51
2				30.833						80.34	55
3				32.333						52.26	56
4				28.5							54
5				26							52
6											52
7											42
8											51
9						15%bare					39
10						10%shrub	Sand				46
Avg/Tot	10	2	5	30.0832	6	75%grass	2	20.8	6.9	73.06	49.8
						1.95					

Salmon Creek, Section C11, Burritt Rd.

Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				40.167						92.72	28
2				38						88.56	42
3				34.333						92.98	42
4				33.083							39
5				34.833							37
6											35
7											31
8											28
9											26
10						92%shrub	Cobble				31
Avg/Tot	0		10	36.0832	7	8%trees	4	19.3	7.1	91.42	33.9
						3.08					

Salmon Creek, Section C11, Burritt Rd.

Jul-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				39.75						92.98	10
2				38.167						94.02	26
3				34.5						89.86	20
4				31.5							17
5				32.333							15
6											13
7											7
8											13
9											24
10						90%shrubs					22
Avg/Tot	20	2	5	35.25	6	10%trees	Cobble	21.5	7.8	92.28667	16.7
						3.1	4				

Salmon Creek, Section C11, Burritt Rd.

Aug-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				39.333						96.36	36
2				37.75						94.28	38
3				33.333						92.72	35
4				34							41
5				34.333							46
6											26
7											33
8											35
9											32
10						90%grass					29
Avg/Tot	10	2	5	35.7498	6	10%trees	Cobble	20.7	7.4	94.45333	35.1
						2.2	4				

Salmon Creek, Burritt, Sec 2

Msmt #	Aug-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				34.25				35.88	48	0	0.05
2				34.5				16.64	48	0.037	0.087
3				34.75				8.06	42	0	0.13
4				35					37		
5				30.833				64.12	47		
6								83.36	30		
7								91.94	22		
8									21		
9									44		
10					100%grass				28		
Avg/Tot	40	1	90	33.8666	2	4	17	79.80667	36.7	0.012	0.089

Salmon Creek, Burritt, Sec 3

Msmt #	Aug-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				33.5				3.12	25	0.097	0.06
2				33.583				2.86	31	0	0.06
3				33				4.16	39	0.043	0.06
4				32.333					29		
5				35.667				96.88	25		
6								97.14	21		
7								95.84	23		
8									22		
9					10%bare				15		
10					90%grass				12		
Avg/Tot	30	1	30	33.6166	1.9	4	17	96.62	24.2	0.047	0.060

Salmon Creek, Ogden-Parma, Sec 2

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Aug-99										
1				20				3.12	27	0.723	0.347
2				16.167				3.64	22	0.017	0.313
3				14.917				13	16	0.317	0.023
4				25.5					19		
5				25.833				96.88	18		
6								96.36	10		
7								87	14		
8									11		
9					50%bare				12		
10					50%grass				19		
Avg/Tot	10	1	20	20.4834	1.5	3	19	93.41333	16.8	0.352	0.228

Salmon Creek, Ogden-Parma, Sec 5

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
	Aug-99										
1				16.25				66.56	31	0.097	0.08
2				18.167				66.56	40	0.097	0.093
3				20.083				67.34	34	0.06	0.113
4				20.417					28		
5				20.25				33.44	41		
6								33.44	39		
7								32.66	30		
8					10%trees				43		
9					10%shrub				40		
10					80%grass				45		
Avg/Tot	35	1	15	19.0334	2.3	5	18	33.18	37.1	0.085	0.095

Salmon Creek, Ogden-Parma, Sec 1

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				23.5				3.38	31	0.1	0.007
2				21.583				4.16	29	0.02	0.02
3				26.167				5.72	11	0.123	0.167
4				26.333					12		
5				22.667				96.62	7		
6								95.84	23		
7								94.28	13		
8									15		
9					85%bare				15		
10					15%grass				17		
Avg/Tot	20	2	5	24.05	1.15	6	17	95.58	17.3	0.081	0.065

Salmon Creek, Ogden-Parma, Sec 3

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				24				26	10	0.223	0.013
2				24.25				22.62	12	0.067	0.163
3				22.833				22.62	17	0.003	0.123
4				21.583					16		
5				24.75				74	22		
6								77.38	12		
7								77.38	18		
8									15		
9					50%shrub				17		
10					50%grass				12		
Avg/Tot	10	1	10	23.4832	2.5	3	17	76.25333	15.1	0.098	0.100

Salmon Creek, Burritt, Sec 2

Sep-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				32.417				4.16	27	0.043	0.067
2				35				8.58	42	0.01	0.09
3				34.083				16.64	33	0.107	0.077
4				30.5					41		
5				29.167				95.84	42		
6								91.42	19		
7								83.36	24		
8									18		
9									18		
10					100%grass				22		
Avg/Tot	15	1	10	32.2334	2	6	15	90.20667	28.6	0.053	0.078

Salmon Creek, Burritt, Sec 5

Sep-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr	middle curr
1				40.167				6.5	23	0.01	0.04
2				39.667				5.98	12	0.087	0.077
3				38.167				3.9	15	0.007	0.003
4				39.417					17		
5				39.5				93.5	14		
6								94.02	23		
7								96.1	18		
8					20%bare				24		
9					5%trees				33		
10					75%grass				22		
Avg/Tot	10	1	10	39.3836	1.9	4	16	94.54	20.1	0.035	0.040

Salmon Creek, Ogden-Parma, Sec 1

Msmt #	Oct-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				23.167				7.28	23	0	0.143
2				26.833				6.76	34	0.08	0.133
3				24.667				11.44	35	0.27	0.07
4				23.417					12		
5				23.583				92.72	14		
6								93.24	14		
7								88.56	11		
8									17		
9					85%bare				15		
10					15%grass				20		
Avg/Tot	10	1	10	24.3334	1.15	3	11	91.50667	19.5	0.117	0.115

Salmon Creek, Ogden-Parma, Sec 2

Msmt #	Oct-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				26.333				3.12	16	0.003	0.413
2				13.417				9.88	15	0.23	0.19
3				16.167				3.12	16	0.093	0.117
4				18					18		
5				17.75				96.88	14		
6								90.12	19		
7								96.88	21		
8									13		
9					50%grass				11		
10					50%bare				13		
Avg/Tot	5	2	5	18.3334	1.5	6	11	94.62667	15.6	0.109	0.240

Salmon Creek, Burritt, Sec 2

	Oct-99										
Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				34.417				21.06	23	0.09	0.15
2				34				10.4	25	0.08	0.1
3				34.5				6.76	27	0	0.003
4				28.833					19		
5				32.75				78.94	43		
6								89.6	43		
7								93.24	35		
8									39		
9					50%grass				42		
10					50%shrub				39		
Avg/Tot	5	1	7	32.9	2.5	6	8	87.26	33.5	0.057	0.084

Salmon Creek, Burritt, Sec 4

	Oct-99										
Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				40.333				9.62	23	0.127	0.077
2				40.25				8.58	22	0.003	0.063
3				37.5				20.54	20	0.12	0.1
4				40.083					22		
5				39.083				90.38	19		
6								91.42	24		
7								79.46	34		
8					68%bare				36		
9					2%trees				26		
10					30%grass				18		
Avg/Tot	5	2	7	39.4498	1.36	4	8	87.08667	24.4	0.083	0.080

Salmon Creek, Ogden-Parma, Sec3

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				27.583				30.94	29	0.697	0.153
2				25.5				32.5	30	0.45	0.183
3				24.167				17.16	34	0.56	0.303
4				22.583					32		
5				25.5				69.06	21		
6								67.5	26		
7								82.84	27		
8									29		
9					50%bare				30		
10					50%grass				23		
Avg/Tot	5	1	15	25.0666	1.5	3	7	73.13333	28.1	0.569	0.213

Salmon Creek, Ogden-Parma, Sec4

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				20.25				73.58	39	0.267	0.447
2				20.25				66.04	41	0.39	0.45
3				21.75				52	51	0.357	0.54
4				23.667					53		
5				24.333				26.42	54		
6								33.96	34		
7								48	54		
8					15%bare				59		
9					75%grass				50		
10					10%trees				54		
Avg/Tot	20	1	10	22.05	2.05	4	7	36.12667	48.9	0.338	0.479

Salmon Creek, Burritt, Sec 1

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				26				82.68	54	0.497	0.357
2				28.667				60.06	47	0.023	0.32
3				32.5				41.86	52	0	0.257
4				31.667					45		
5				33.083				17.32	46		
6								39.94	42		
7								58.14	41		
8									42		
9					55%bare				49		
10					45%grass				57		
Avg/Tot	4	2	0	30.3834	1.45	4	7	38.46667	47.5	0.173	0.311

Salmon Creek, Burritt, Sec 2

Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				33.25				28.34	64	0.13	0.187
2				34.25				17.68	64	0.247	0.343
3				35.75				9.36	58	0.067	0.213
4				35.75					55		
5				35.583				71.66	40		
6								82.32	45		
7								90.64	43		
8									44		
9									51		
10					100%grass				46		
Avg/Tot	3	2	7	34.9166	2	6	7	81.54	51	0.148	0.248

Salmon Creek, Ogden-Parma, Sec3
Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				24.5				23.66	34	0.557	0.107
2				24.083				31.98	32	0	0.083
3				24.25				14.82	34	0.547	0.227
4				27.583					30		
5				27.833				76.34	32		
6								68.02	35		
7								85.18	32		
8									32		
9									35		
10					100%grass				28		
Avg/Tot	5	1	2	25.6498	2	3	-1	76.51333	32.4	0.368	0.139

Salmon Creek, Ogden-Parma, Sec5
Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				26.25				44.72	53	0.31	0.45
2				25				64.48	44	0.453	0.33
3				24.5				58.76	52	0.24	0.303
4				22.583					54		
5				21.5				55.28	45		
6								35.52	60		
7								41.24	51		
8									61		
9					90%grass				50		
10					10%trees				49		
Avg/Tot	20	1	10	23.9666	2.2	4	-1	44.01333	51.9	0.334	0.361

Salmon Creek, Burritt, Sec 2

Msmt #	Dec-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				35.583				8.06	32	0.15	0.187
2				35.417				14.56	42	0.26	0.33
3				35.667				26	50	0.07	0.343
4				33.75					62		
5				33.167				91.94	59		
6								85.44	58		
7								74	56		
8									64		
9									64		
10					100%grass				58		
Avg/Tot	10	2	0	34.7168	2	5	-1	83.79333	54.5	0.160	0.287

Salmon Creek, Burritt, Sec 3

Msmt #	Dec-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				27.583				3.12	36	0.183	0.197
2				25.5				4.68	39	0.247	0.213
3				24.167				4.16	44	0.13	0.197
4				22.583					37		
5				25.5				96.88	37		
6								95.32	45		
7								95.84	50		
8									42		
9									46		
10					100%grass				55		
Avg/Tot	5	1	0	25.0666	2	4	-1	96.01333	43.1	0.187	0.202

Northrup Creek, Section A1, Big Ridge Road at BOCES

Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				13.167						63.7	33
2				10.417						46.8	43
3				11.083						67.86	29
4				12.167							34
5				24.583							36
6											33
7											20
8											26
9											36
10						31%trees	Cobble				48
Avg/Tot	0		25	14.2834	6	69%grass	4	21.5	6.6	59.45333	33.8
						2.62					

Northrup Creek, Section A1, Big Ridge Road at BOCES

7/26/98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				24						54.6	28
2				12						52.78	22
3				10.833						14.3	18
4				9.667							44
5				12.667							30
6											31
7											17
8											27
9											16
10						25%shrub					18
Avg/Tot	20	2	15	13.8334	6	75%grass	Cobble	23		40.56	25.1
						2.25	4				

Northrup Creek, Section A1, Big Ridge Road at BOCES
8/29/98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				12.833						20.28	71
2				13						7.28	62
3				13.167						3.64	61
4				12.167							47
5				11.833							43
6											38
7											34
8											31
9						10%bare					36
10						75%shrub					42
Avg/Tot	20	1	45	12.6	6	15%trees	Cobble	24.2	6.6	10.4	46.5
						2.95	4				

Northrup Creek, Section A4, Big Ridge Road at BOCES
Jun-98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				13.25						5.56	70
2				12.5						42.64	62
3				13.5						23.14	61
4				13.5							44
5				12.75							48
6											43
7											40
8											33
9											38
10						97%trees	Gravel				34
Avg/Tot	10	2	85	13.1	6	3%grass	3	21.5	6.7	23.78	47.3
						3.94					

Northrup Creek, Section A4, Big Ridge Road at BOCES
7/26/98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				13						22.88	60
2				12.75						2.34	67
3				12.5						17.94	68
4				12.5							59
5				12.167							49
6											43
7											37
8											35
9						55%shru					38
10						40%tree					32
Avg/To	30	1	90	12.5834	6	5%grass	Gravel	23		14.38667	48.8
						3.35	3				

Northrup Creek, Section A4, Big Ridge Road at BOCES
8/29/98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				15.167						68.12	26
2				18						39	36
3				12						7.02	17
4				10.167							38
5				10.833							27
6											29
7											19
8											30
9											28
10						75%shrub	sand				7
Avg/Tot	10	1	30	13.2334	6	25%grass 2.75	2	24.1	6.3	38.04667	25.7

Northrup Creek, Section B10, Big Ridge Road at Sewage Treatment Plant

June 98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				22.333						0	40
2				20.417						0	51
3				21						0	35
4				20.5							38
5				23							34
6											41
7											40
8											40
9											48
10						5%shrub	sand				46
Avg/Tot	20	1	75	21.45	6	95%grass	2	21.3	6.7	0	41.3
						2.05					

7/26/98

Msmt #	% Pools	PoolClass	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth(cm)
1				20.333						0	38
2				19.667						0	29
3				18						0	26
4				20							31
5				20.5							29
6											26
7											27
8											30
9											34
10						10%shrub	sand				39
Avg/Tot	50	1	97	19.7	6	90%grass	2	23		0	30.9
						2.1					

Northrup Creek, Section B10, Big Ridge Road at Sewage Treatment Plant
8/29/98

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	pH	% Veg	Substrate	Temp (C)	Diss Ox	% Shaded	Depth (cm)
1				20.833						0	22
2				19.667						0	30
3				19						0	42
4				19.5							32
5				19.833							30
6											33
7											29
8											31
9											32
10						5%shrub					28
Avg/Tot	10	1	95	19.7666	6	95%grass	sand	24.2	6.5	0	30.9
						2.05	2				

Northrup Creek, BOCES, Sec 2
Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				15				85.28	28	0.42	0.35
2				13				85.54	25	0	0.297
3				20.5				16.9	36	0.213	0.293
4				20.583					42		
5				23.25				14.72	34		
6								14.46	39		
7								83.1	35		
8									42		
9					10%grass				42		
10					90%shrub				48		
Avg/Tot	15	2	10	18.4666	2.9	2	14	37.42667	37.1	0.211	0.313

Northrup Creek, BOCES, Sec 3
Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				12.083				5.98	44	0.053	0.243
2				11.5				5.98	32	0.16	0.233
3				14.167				21.06	39	0.087	0.3
4				26.5					40		
5				12.75				94.02	37		
6								94.02	26		
7								78.94	56		
8									31		
9					10%trees				54		
10					90%shrub				55		
Avg/Tot	30	1	25	15.4	3.1	4	15	88.99333	41.4	0.100	0.259

Northrup Creek, Sewage, Sec 3

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				17.833				97.24	32	0.323	0.327
2				18.667				87.88	30	0.15	0.213
3				20.583				82.94	30	0.097	0.38
4				20.083					31		
5				19.25				2.76	28		
6								12.12	47		
7								17.06	34		
8									43		
9					98%grass				35		
10					2%shrubs				28		
Avg/Tot	10	1	75	19.2832	2.02	2	14	10.64667	33.8	0.190	0.307

Northrup Creek, Sewage, Sec 5

Aug-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				21.25				100	34	0.61	0.1
2				20				100	24	0.46	0.283
3				19.667				100	26	0.32	0.177
4				19.5					24		
5				18.083				0	32		
6								0	15		
7								0	22		
8									22		
9					96%grass				21		
10					4%shrub				22		
Avg/Tot	5	1	60	19.7	2.04	2	14	0	24.2	0.463	0.187

Northrup Creek, BOCES, Sec 3

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				13.5				28.08	44	0.077	0.213
2				21.917				23.14	57	0.21	0.27
3				12.5				39.52	56	0.097	0.287
4				12.667					44		
5				14.75				71.92	44		
6								76.86	39		
7								60.48	41		
8					30%bare				52		
9					5%trees				58		
10					65%shrub				45		
Avg/Tot	20	1	25	15.0668	2.45	1	17	69.75333	48	0.128	0.257

Northrup Creek, BOCES, Sec 4

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				14.083				48.62	45	0.28	0.347
2				13.5				59.8	35	0.243	0.327
3				14.167				39	44	0.36	0.383
4				14.583					52		
5				13.5				51.38	48		
6								40.2	53		
7								61	64		
8					40%bare				69		
9									71		
10					60%grass				66		
Avg/Tot	5	2	10	13.9666	1.6	1	17	50.86	54.7	0.294	0.352

Northrup Creek, Sewage, Sec 1

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				12				82.42	26	0.203	0.257
2				16.333				84.5	50	0.623	0.373
3				18				63.44	36	0.563	0.407
4				18.417					25		
5				25.167				17.58	40		
6								15.5	19		
7								36.56	37		
8									29		
9					15%shrub				39		
10					85%grass				46		
Avg/Tot	60	1	80	16.1875	2.15	1	17	23.21333	34.7	0.463	0.346

Northrup Creek, Sewage, Sec 5

Msmt #	Sep-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				23.25				97.24	32	0.46	0.3
2				20.583				99.58	27	0.197	0.313
3				18.667				91	38	0.28	0.34
4				19.917					37		
5				21.25				2.76	28		
6								0.42	37		
7								9	30		
8									29		
9					65%shrub				34		
10					35%grass				42		
Avg/Tot	70	1	90	20.7334	2.65	1	17	4.06	33.4	0.312	0.318

Northrup Creek, BOCES, Sec 4

Oct-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				15.417				58.76	72	0.22	0.297
2				19.75				56.42	67	0.113	0.28
3				13.167				52.78	66	0.167	0.247
4				14.75					71		
5				13.5				41.24	68		
6								43.58	59		
7								47.22	40		
8					50%bare				72		
9					45%grass				66		
10					5%shrub				54		
Avg/Tot	20	1	30	15.3168	1.55	1	12	44.01333	63.5	0.167	0.275

Northrup Creek, BOCES, Sec 5

Oct-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				14.167				89.18	38	0.147	0.223
2				20.583				69.16	41	0.277	0.277
3				17.75				57.46	41	0.17	0.357
4				16.25					48		
5				16				10.82	41		
6								30.84	45		
7								42.54	55		
8					10%bare				47		
9					85%grass				59		
10					5%shrub				59		
Avg/Tot	35	1	40	16.95	1.95	1	12	28.06667	47.4	0.198	0.286

Northrup Creek, Sewage, Sec 1

Msmt #	Oct-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				20				69.16	32	0.207	0.733
2				15.167				73.84	28	0.22	0.76
3				18.5				84.24	17	0.217	0.763
4				17.167					17		
5				18.5				30.84	18		
6								26.16	34		
7								15.76	23		
8									34		
9					90%grass				36		
10					10%shrub				52		
Avg/Tot	60	1	75	17.8668	2.1	2	12	24.25333	29.1	0.215	0.752

Northrup Creek, Sewage, Sec 4

Msmt #	Oct-99 % Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				18.25				98.8	36	0.48	0.463
2				20.417				100	30	0.49	0.307
3				21				97.76	43	0.217	0.573
4				22.083					33		
5				23.5				1.2	23		
6								0	27		
7								2.24	30		
8									20		
9					40%grass				18		
10					60%shrub				20		
Avg/Tot	10	1	85	21.05	2.6	1	12	1.146667	28	0.396	0.448

Northrup Creek, BOCES, Sec 4
Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				14.75				58.76	59	0.04	0.103
2				14.167				62.14	53	0	0.09
3				12.417				66.3	62	0	0.057
4				12.25					57		
5				13				41.24	60		
6								37.86	49		
7								33.7	50		
8									59		
9									56		
10					100%grass				46		
Avg/Tot	30	1	10	13.3168	2	2	4	37.6	55.1	0.013	0.083

Northrup Creek, BOCES, Sec 5
Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				14.333				67.08	32	0.067	0.09
2				14.667				67.34	39	0.103	0.107
3				11.083				93.86	33	0.003	0.127
4				13.167					32		
5				15.167				32.92	26		
6								32.66	12		
7								6.14	21		
8									36		
9									41		
10					100%grass				29		
Avg/Tot	30	1	10	13.6834	2	5	4	23.90667	30.1	0.058	0.108

Northrup Creek, Sewage, Sec 1
Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				10				74.62	22	0.203	0.257
2				10.25				78.78	15	0.623	0.373
3				10.333				76.44	18	0.197	0.407
4				8.917					23		
5				16.417				25.38	11		
6								21.22	17		
7								23.56	27		
8									19		
9					45%bare				31		
10					55%grass				41		
Avg/Tot	10	1	40	11.1834	1.55	5	4	23.38667	22.4	0.341	0.346

Northrup Creek, Sewage, Sec 5
Nov-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				14.75				100	10	0.46	0.3
2				14.167				100	13	0.197	0.313
3				12.417				100	15	0.28	0.34
4				12.25					20		
5				13				0	15		
6								0	25		
7								0	16		
8									15		
9					10%shrubs				14		
10					90%grass				20		
Avg/Tot	20	1	75	13.3168	2.1	1	4	0	16.3	0.312	0.318

Northrup Creek, BOCES, Sec 5

Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				16.5				89.7	31	0.063	0.14
2				16.833				83.2	35	0.22	0.247
3				14.5				71.5	35	0.173	0.143
4				16.083					40		
5				18.417				10.3	25		
6								16.8	25		
7								28.5	35		
8									43		
9					43%bare				42		
10					57%grass				46		
Avg/Tot	40	1	35	16.4666	1.57	2	0	18.53333	35.7	0.152	0.177

Northrup Creek, BOCES, Sec 1

Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				16				61.36	29	0.07	0.09
2				12.5				55.64	21	0.097	0.15
3				8.833				40.04	23	0.14	0.163
4				14.167					22		
5				12.417				38.64	30		
6								44.36	21		
7								59.96	40		
8									28		
9									25		
10					100%grass				28		
Avg/Tot	10	2	5	12.7834	2	2	0	47.65333	26.7	0.102	0.134

Northrup Creek, Sewage, Sec 1

Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				10				82.42	27	0.297	0.253
2				9.417				81.64	29	0.14	0.21
3				11.333				85.02	22	0.197	0.413
4				11.083					28		
5				16.333				17.58	25		
6								18.36	25		
7								14.98	28		
8									33		
9					50%bare				45		
10					50%grass				51		
Avg/Tot	40	1	20	11.6332	1.5	5	1	16.97333	31.3	0.211	0.292

Northrup Creek, Sewage, Sec 2

Dec-99

Msmt #	% Pools	Pool Class	% Cover	Width (ft)	% Veg	Substrate	Temp (C)	% Shaded	Depth (cm)	edge curr (m/sec)	middle curr (m/sec)
1				16.167				76.7	21	0.02	0.167
2				18.5				45.24	14	0.33	0.423
3				22.5				77.74	16	0.217	0.647
4				12.583					19		
5				10.667				23.3	18		
6								54.76	22		
7								22.26	17		
8					45%bare				16		
9					50%grass				21		
10					5%trees				28		
Avg/Tot	20	1	35	16.0834	1.65	2	1	33.44	19.2	0.189	0.412

APPENDIX B: INTRA-STREAM ANALYSIS

Since only two sites were sampled in each stream, it was necessary to compare those sites to each other within each stream to determine if the measurements for each habitat parameter were similar between sections of stream. If not, the data collected for that parameter from those streams could not be used to compare streams to each other since it could not be concluded that differences did not exist within each stream. A nested ANOVA was performed on the mean values for each habitat parameter, in each section, at each site, in each stream. The following is the results of those tests. The data for each stream section represents the mean of all measurements made at that section during the project. Vegetation Index = [4*(%trees)+ 3*(%shrubs)+ 2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Depth (cm)

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	25	51.83333	39.56667	18.4	28.53333	29.375	
2	30.8	26.15	40.86	16.2	37.1	19.2	
3	34.9	30	33.65	22.26	44.7	33.8	
4	36.9	45.28	25	48.9	53.88	28	
5	20.4	55.7	20.1	44.5	37.7	29.22	
n	5	5	5	5	5	5	
SUM	148	208.96333	159.17667	150.26	201.91333	139.595	among subgp SS var
SUM^2/n	4380.8	8733.134657	5067.442454	4515.61352	8153.798566	3897.352805	34748.14
							C var
stream SUM		356.96333		309.43667		341.50833	1007.908
							gp SS var
stream $SUM^2/(n+n)$		12742.2819		9575.105274		11662.79395	33980.18

C	33862.64006				
total SS	3519.199944	among SS	885.5019466	error SS	2633.698
group SS	117.5410604	subgp SS	767.9608863		

	SS	DF	MS
Total	3519.199944	29	
among subgp	885.5019466	14	
group	117.5410604	2	58.77053018
subgroup	767.9608863	12	63.99674052
error	2633.697997	15	175.5798665

F subgp	0.36	$F_{.25(1)12,15} = 1.44$
F group	0.92	$F_{.05(1)2,12} = 3.89$

% Shaded Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	14.408	82.29111	61.47111	93.54333	49.22222	0.812	
2	14.02667	78.50667	85.52133	94.02	37.42667	33.4	
3	28.38444	83.1	96.31667	80.36133	79.37333	10.64667	
4	27.17111	84.99467	90.26444	36.12667	34.128	1.14667	
5	14.74889	92.54667	94.54	36.59667	23.50222	20.96	
	19.747822	84.287824	85.62271	68.1296	44.730488	13.393068	
SUM	98.73911	421.43912	428.11355	340.648	223.65244	66.96534	
n	5	5	5	5	5	5	among subgp SS var
SUM^2/n	1949.882369	35522.18637	36656.24234	23208.21198	10004.08278	896.8713523	108237.5
stream SUM		520.17823		768.76155		290.61778	C var 1579.558
stream SUM^2/(n+n)		27058.5391		59099.43208		8445.869405	gp SS var 94603.84

C	83166.73618				
total SS	32287.26382	among SS	25070.74102	error SS	7216.523
group SS	11437.1044	subgp SS	13633.63662		

	SS	DF	MS
Total	32287.26382	29	
among subgp	25070.74102	14	
group	11437.1044	2	5718.5522
subgroup	13633.63662	12	1136.136385
error	7216.522803	15	481.1015202

F subgp	2.36	F.25(1)12,15 = 1.44		
F group	5.03	F.05(1)2,12 = 3.89	min det	47.16

Middle Current (cm/sec)
Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	44.4	48.9	31.1	9	17.7	42.5	
2	33.2	34.9	15.7	23.4	31.3	41.2	
3	42.6	61.9	13.1	15.1	25.8	30.7	
4	31.8	53.1	8	47.9	23.7	44.8	
5	35.7	46.9	4	22.8	19	30.6	
n	5	5	5	5	5	5	
SUM	187.7	245.7	71.9	118.2	117.5	189.8	
							among subgp SS var
SUM^2/n	7046.258	12073.698	1033.922	2794.248	2761.25	7204.808	32914.18
							C var
stream SUM		433.4		190.1		307.3	930.8
							gp SS var
stream $SUM^2/(n+n)$		18783.556		3613.801		9443.329	31840.69

C	28879.62133				
total SS	6161.538667	among SS	4034.562667	error SS	2126.976
group SS	2961.064667	subgp SS	1073.498		

	SS	DF	MS
Total	6161.538667	29	
among subgp	4034.562667	14	
group	2961.064667	2	1480.532333
subgroup	1073.498	12	89.45816667
error	2126.976	15	141.7984

F subgp	0.63	$F_{.25(1)12,15} = 1.44$
F group	16.55	$F_{.05(1)2,12} = 3.89$

Temperature °C

			Site			
Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage
1	7.5	17.8	15.93	14	14.83	8.5
2	9	12	9.2	15	14	1
3	9	7	8	13.2	16	14
4	17.57	15.34	16.27	7	15.5	12
5	13.33	8	16	8.5	5.33	15.86
n	5	5	5	5	5	5
SUM	56.4	60.14	65.4	57.7	65.66	51.36
SUM^2/n	636.192	723.36392	855.432	665.858	862.24712	527.56992
stream SUM		116.54		123.1		117.02
stream $SUM^2/(n+n)$		1358.15716		1515.361		1369.36804

among subgp SS var 4270.663

C var 356.66

gp SS var 4242.886

C	4240.211853				
total SS	518.5731467	among SS	30.45110667	error SS	488.122
group SS	2.674346667	subgp SS	27.77676		

	SS	DF	MS
Total	518.5731467	29	
among subgp	30.45110667	14	
group	2.674346667	2	1.337173333
subgroup	27.77676	12	2.31473
error	488.12204	15	32.54146933

F subgp	0.07	F.25(1)12,15 = 1.44
F group	0.58	F.05(1)2,12 = 3.89

Substrate (numerical representation)

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage		
1	3.5	4.66667	4.66667	4.5	3.33333	3.25		
2	2	3.5	5.4	4.5	2	2		
3	3.7	6	4	3	2.5	2		
4	4.33333	4.4	4	4	2	1		
5	3.7	4.7	4	4.5	2.7	1.2		
n	5	5	5	5	5	5		
SUM	17.23333	23.26667	22.06667	20.5	12.53333	9.45		
							among subgp SS var	
SUM^2/n	59.39753258	108.2675866	97.38758498	84.05	31.41687218	17.8605	398.3801	
								C var
stream SUM		40.5		42.56667		21.98333		105.05
								gp SS var
stream $SUM^2/(n+n)$		164.025		181.1921395		48.32667979		393.5438

C	367.8500833				
total SS	44.37691667	among SS	30.52999298	error SS	13.84692
group SS	25.69373594	subgp SS	4.836257033		

	SS	DF	MS
Total	44.37691667	29	
among subgp	30.52999298	14	
group	25.69373594	2	12.84686797
subgroup	4.836257033	12	0.403021419
error	13.84692369	15	0.923128246

F subgp	0.44	$F_{.25(1)12,15} = 1.44$
F group	31.88	$F_{.05(1)2,12} = 3.89$

Vegetation Index

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	2.05	1.61	2.633333	1.15	2.29	1.825	
2	2	2.3	2.1	1.5	2.9	1.65	
3	1.57	1.75	2	1.84	2.775	2.02	
4	1.716667	1.92	2.513333	2.05	2.488	2.6	
5	2	1.88	1.9	2.25	1.84	2.188	
n	5	5	5	5	5	5	
SUM	9.336667	9.46	11.146666	8.79	12.293	10.283	
							among subgp SS var
SUM^2/n	17.43467013	17.89832	24.84963258	15.45282	30.2235698	21.1480178	127.007
							C var
stream SUM		18.796667		19.936666		22.576	61.30933
							gp SS var
stream $SUM^2/(n+n)$		35.33146903		39.74706512		50.9675776	126.0461

C	125.2944771				
total SS	4.591022903	among SS	1.71255322	error SS	2.87847
group SS	0.751634654	subgp SS	0.960918566		

	SS	DF	MS
Total	4.591022903	29	
among subgp	1.71255322	14	
group	0.751634654	2	0.375817327
subgroup	0.960918566	12	0.080076547
error	2.878469683	15	0.191897979

F subgp 0.42 $F_{.25(1)12,15} = 1.44$

F group 4.69 $F_{.05(1)2,12} = 3.89$

% Cover

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	30	18.33333	4	10	15	53.75	
2	80	3.5	22.8	12.5	10	35	
3	40	3	15	8.4	25	75	
4	11.66667	13	7.333333	10	45	85	
5	43.3	14.3	10	12.5	28.3	79.4	
n	5	5	5	5	5	5	
SUM	204.96667	52.13333	59.133333	53.4	123.3	328.15	
							among subgp SS var
SUM^2/n	8402.267162	543.5768194	699.3502143	570.312	3040.578	21536.4845	34792.57
							C var
stream SUM		257.1		112.533333		451.45	821.0833
							gp SS var
stream $SUM^2/(n+n)$		6610.041		1266.375104		20380.71025	28257.13

C 22472.59466

total SS 17711.24534 | among SS 12319.97404 | error SS 5391.271

group SS 5784.531696 | subgp SS 6535.442342

	SS	DF	MS
Total	17711.24534	29	
among subgp	12319.97404	14	
group	5784.531696	2	2892.265848
subgroup	6535.442342	12	544.6201952
error	5391.271304	15	359.4180869

F subgp 1.52 $F_{.25(1)12,15} = 1.44$

min det 40.76

F group 5.31 $F_{.05(1)2,12} = 3.89$

Pool Class Rating

			Site					
Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage		
1	1	1	2	1.5	2	1		
2	1	2	1.4	1.5	2	1		
3	1	1	1.5	1.6	1	1		
4	1.3333333	1.2	2	1	1.4	1		
5	1	1.3333333	1	1	1	1		
n	5	5	5	5	5	5		
SUM	5.3333333	6.5333333	7.9	6.6	7.4	5	among subgp SS var	
SUM^2/n	5.688888818	8.536888802	12.482	8.712	10.952	5	51.37178	
								C var
stream SUM		11.8666666		14.5		12.4		38.76667
								gp SS var
stream $SUM^2/(n+n)$		14.08177762		21.025		15.376		50.48278
	C	50.09514798						
	total SS	4.130412024		among SS	1.276629644		error SS	2.853782
	group SS	0.387629644		subgp SS	0.889			

	SS	DF	MS
Total	4.130412024	29	
among subgp	1.276629644	14	
group	0.387629644	2	0.193814822
subgroup	0.889	12	0.074083333
error	2.85378238	15	0.190252159

F subgp 0.39 $F_{.25(1)12,15} = 1.44$

F group 2.62 $F_{.05(1)2,12} = 3.89$

% Pools

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	10	26.666667	13	15	10	42.5	
2	10	4	14.6	7.5	15	20	
3	20	15	17.5	8	25	10	
4	14	18	8.33333	20	19	10	
5	13.3	36.7	10	27.5	35	33	
n	5	5	5	5	5	5	
SUM	67.3	100.366667	63.43333	78	104	115.5	
SUM^2/n	905.858	2014.693569	804.757471	1216.8	2163.2	2668.05	among subgp SS var 9773.359
stream SUM		167.666667		141.43333		219.5	C var 528.6
stream $SUM^2/(n+n)$		2811.211122		2000.338683		4818.025	gp SS var 9629.575

C	9313.931894				
total SS	2672.568106	among SS	459.4271456	error SS	2213.141
group SS	315.6429115	subgp SS	143.7842341		

	SS	DF	MS
Total	2672.568106	29	
among subgp	459.4271456	14	
group	315.6429115	2	157.8214557
subgroup	143.7842341	12	11.98201951
error	2213.14096	15	147.5427307

F subgp	0.08	$F_{.25(1)12,15} = 1.44$
F group	13.17	$F_{.05(1)2,12} = 3.89$

Edge Current (cm/sec)

Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage	
1	22.3	50.1	17.3	9.9	10.2	27.5	
2	28.7	18.7	8.6	23.1	21.1	18.9	
3	20.9	52.4	11.7	33.8	11.4	19	
4	31.5	31.7	8.3	33.8	15.8	39.6	
5	35.1	16.3	3.5	21	13.6	32.2	
n	5	5	5	5	5	5	
SUM	138.5	169.2	49.4	121.6	72.1	137.2	
							among subgp SS var
SUM^2/n	3836.45	5725.728	488.072	2957.312	1039.682	3764.768	17812.01
							C var
stream SUM		307.7		171		209.3	688
							gp SS var
stream $SUM^2/(n+n)$		9467.929		2924.1		4380.649	16772.68

C	15778.13333				
total SS	4222.006667	among SS	2033.878667	error SS	2188.128
group SS	994.5446667	subgp SS	1039.334		

	SS	DF	MS
Total	4222.006667	29	
among subgp	2033.878667	14	
group	994.5446667	2	497.2723333
subgroup	1039.334	12	86.61116667
error	2188.128	15	145.8752

F subgp	0.59	$F_{.25(1)12,15} = 1.44$
F group	5.74	$F_{.05(1)2,12} = 3.89$

Width (ft)
Site

Section	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage		
1	48.7416	41.34993	29.83227	24.1917	13.6334	14.67304		
2	70.7334	33.4835	33.72668	19.4084	18.4666	16.0834		
3	40.2278	28.1332	29.3416	23.45992	15.2334	19.2832		
4	50.3778	34.04656	36.92767	22.05	13.65672	21.05		
5	86.75713	32.08893	39.3836	21.5	14.47227	18.98004		
n	5	5	5	5	5	5		
SUM	296.83773	169.10212	169.21182	110.61002	75.46239	90.06968	among subgp SS var	
SUM^2/n	17622.52759	5719.105398	5726.528006	2446.915305	1138.914461	1622.509451	34276.5	C var
stream SUM		465.93985		279.82184		165.53207		911.2938
								gp SS var
stream $SUM^2/(n+n)$		21709.99438		7830.026214		2740.08662		32280.11

C	27681.87723				
total SS	8259.282766	among SS	6594.622977	error SS	1664.66
group SS	4598.229982	subgp SS	1996.392995		

	SS	DF	MS
Total	8259.282766	29	
among subgp	6594.622977	14	
group	4598.229982	2	2299.114991
subgroup	1996.392995	12	166.3660829
error	1664.65979	15	110.9773193

F subgp	1.50	F.25(1)12,15 = 1.44	min det	22.65
F group	13.82	F.05(1)2,12 = 3.89		

pH

Site

Month	Sandy Creek Church	Sandy Creek Murray	Salmon Creek Burritt	Salmon Creek O-P	Northrup Creek BOCES	Northrup Creek Sewage		
June	6	7	6.5	6	6	6		
July	7	6	6	7	6	6		
Aug	6	6	6	6	6	6		
n	3	3	3	3	3	3		
SUM	19	19	18.5	19	18	18		among subgp SS var
SUM^2/n	120.3333333	120.3333333	114.0833333	120.3333333	108		108	691.0833
								C var
stream SUM		38		37.5			36	111.5
								gp SS var
stream $SUM^2/(n+n)$		240.6666667		234.375			216	691.0417

C	690.6805556				
total SS	2.569444444	among SS	0.402777778	error SS	2.166667
group SS	0.361111111	subgp SS	0.041666667		

	SS	DF	MS
Total	2.569444444	17	
among subgp	0.402777778	8	
group	0.361111111	2	0.180555556
subgroup	0.041666667	6	0.006944444
error	2.166666667	9	0.240740741
F subgp	0.03		F.25(1)6,9 = 1.61
F group	26		F.05(1)2,6 = 5.14

APPENDIX C: MONTHLY ANALYSIS

Since this project was conducted over several months, certain habitat parameters (e. g., temperature) naturally varied greatly from month to month. To reduce the effects of monthly variance, the data for these parameters were ranked and the ranks used for stream comparisons. Thus each habitat parameter was tested for significant differences between months within each stream. The null hypothesis was: monthly measurements of habitat parameters within a stream did not differ. Once the null hypothesis (i.e., no differences between months within streams) was rejected for a habitat parameter in one stream it was unnecessary to test that parameter in the remaining streams. The following tables are the results of those monthly tests. Vegetation Index = [4*(%trees)+ 3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Sandy Creek

Temperature °C

June	July	August	September	October	November	December
23.9	22.5	18	15	9	7	0
24	22.7	18	15	9	7	0
21.3	24.4	15	15	9	7	0
		15	15	9	7	0

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	69.2	23.066667	2.343333
Column 2	3	69.6	23.2	1.09
Column 3	4	66	16.5	3
Column 4	4	60	15	0
Column 5	4	36	9	0
Column 6	4	28	7	0
Column 7	4	0	0	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1561.878	6	260.31299	311.7193	6.25E-18	2.628319
Within Groups	15.86667	19	0.8350877			
Total	1577.745	25				

Sandy Creek

Middle Current (cm/sec)

August	September	October	November	December
35.3	36.3	22	30.3	34.3
39	50	39	40.7	43
52	54.7	38.7	24.3	48.3
68.7	24	38.7	42.3	46.3
31	26.3	22.3	32	57.7
29.7	19	48.7	48	43.3
27.3	55.7	44.7	33.7	54.3
59	54.3	19.3	40.3	52.3
65	59.7	13	72.7	50.3
41.7	31.3	53.3	54.3	51
40.3	54	66.7	88.3	32.7
59	47	44.3	43	33

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	12.00	548.00	45.67	209.44
Column 2	12.00	512.30	42.69	207.94
Column 3	12.00	450.70	37.56	248.52
Column 4	12.00	549.90	45.83	338.42
Column 5	12.00	546.50	45.54	71.90

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	602.59	4.00	150.65	0.70	0.60	2.54
Within Groups	11838.30	55.00	215.24			
Total	12440.89	59.00				

Sandy Creek

Substrate (numerical representation)

June	July	August	September	October	November	December
4	5	2	3	2	3	4
4	6	4	3	6	4	3
5	6	2	5	3	4	5
		2	4	6	6	6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	13	4.3333333	0.333333
Column 2	3	17	5.6666667	0.333333
Column 3	4	10	2.5	1
Column 4	4	15	3.75	0.916667
Column 5	4	17	4.25	4.25
Column 6	4	17	4.25	1.583333
Column 7	4	18	4.5	1.666667

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	19.07051	6	3.1784188	2.041351	0.109717	2.628319
Within Groups	29.58333	19	1.5570175			
Total	48.65385	25				

Sandy Creek

Vegetation Index

June	July	August	September	October	November	December
2	2.15	1.85	2	2	2	2.1
1.78	1.85	2	2	1.8	2	1.05
2.4	2.05	1.8	1.8	2.1	1.2	1.55
		1.85	2.5	1.9	1.75	1.9

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	6.18	2.06	0.0988
Column 2	3	6.05	2.0166667	0.023333
Column 3	4	7.5	1.875	0.0075
Column 4	4	8.3	2.075	0.089167
Column 5	4	7.8	1.95	0.016667
Column 6	4	6.95	1.7375	0.142292
Column 7	4	6.6	1.65	0.211667

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.608243	6	0.1013738	1.170071	0.362768	2.628319
Within Groups	1.646142	19	0.086639			
Total	2.254385	25				

Sandy Creek

Pool Class Rating

June	July	August	September	October	November	December
1	2	1	1	1	1	1
1	1	1	1	1	1	1
1	1	2	1	2	1	1
		1	2	2	1	1

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	3	1	0
Column 2	3	4	1.3333333	0.333333
Column 3	4	5	1.25	0.25
Column 4	4	5	1.25	0.25
Column 5	4	6	1.5	0.333333
Column 6	4	4	1	0
Column 7	4	4	1	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.871795	6	0.1452991	0.871795	0.533398	2.628319
Within Groups	3.166667	19	0.1666667			
Total	4.038462	25				

Sandy Creek

Depth (cm)

June	July	August	September	October	November	December
17	50	30	22	35	51	60
28	48	30	16	31	32	60
25	54	42	12	32	33	51
24	38	38	17	33	23	54
53	17	34	10	33	29	45
57	17	31	19	21	29	29
52	31	50	12	19	45	47
34	29	45	14	26	57	29
54	25	54	19	47	52	32
30	21	46	18	31	52	36
61	54	65	8	27	21	54
57	63	54	17	30	45	65
78	65	43	22	40	42	65
68	51	49	26	39	21	56
72	42	56	27	37	20	52
66	63	53	16	38	18	53
68	62	53	19	37	16	58
60	56	59	13	42	28	53
58	52	49	19	44	20	59
57	54	54	25	42	30	52
45	43	48	29	29	40	19
48	39	50	37	27	34	13
50	51	45	35	29	24	14
50	63	45	39	27	36	16
58	59	43	35	20	45	15
55	54	25	57	27	25	11

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	30	1539	51.3	220.70
Column 2	30	1389	46.3	191.94
Column 3	40	1506	37.65	230.80
Column 4	40	1030	25.75	129.27
Column 5	40	1500	37.5	181.08
Column 6	40	1312	32.8	113.55
Column 7	40	1410	35.25	334.04

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	14630.15	6	2438.36	12.21	4.67E-12	2.13
Within Groups	50527.10	253	199.71			
Total	65157.25	259				

50	43	38	45	25	21	17
50	51	39	36	23	40	12
51	44	41	45	24	44	11
63	50	38	46	17	39	13
		22	33	60	22	22
		16	30	51	23	28
		12	32	54	22	33
		17	31	57	30	35
		10	34	60	26	37
		19	32	48	37	31
		12	20	52	35	26
		14	25	61	34	13
		19	26	69	35	20
		18	12	56	36	14

Sandy Creek

pH

June	July	August
6	7	6
7	6	6
7	6	6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	20	6.666667	0.333333
Column 2	3	19	6.333333	0.333333
Column 3	3	18	6	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.666667	2	0.333333	1.5	0.296296	5.143249
Within Groups	1.333333	6	0.222222			
Total	2	8				

Sandy Creek

% Pools

June	July	August	September	October	November	December
25	25	20	10	10	2	10
50	15	5	5	15	30	25
40	15	10	10	3	5	15
		60	5	25	15	25

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	115	38.33333	158.3333
Column 2	3	55	18.33333	33.33333
Column 3	4	95	23.75	622.9167
Column 4	4	30	7.5	8.333333
Column 5	4	53	13.25	85.58333
Column 6	4	52	13	159.3333
Column 7	4	75	18.75	56.25

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2004.532	6	334.0887	1.995761	0.116775	2.628319
Within Groups	3180.583	19	167.3991			
Total	5185.115	25				

Sandy Creek

Edge Current (cm/sec)

August	September	October	November	December
16	18.3	16	38.3	39.7
3.3	27.3	33	31	16.3
6	14.3	37	25.3	17.7
1.7	67	22.3	24.3	28.3
26.7	33	26.7	47.3	29.3
32.7	29.3	27.7	53.7	28.3
51.3	42.7	13	46	55.7
36.3	17	0.7	44.3	0.3
38.3	14.3	9	60	29.7
31.7	15	27.7	52	0
22.7	29.3	19.3	42.3	0
0	45	16.7	63	28.7

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	12.00	266.70	22.23	281.55
Column 2	12.00	352.50	29.38	253.79
Column 3	12.00	249.10	20.76	108.16
Column 4	12.00	527.50	43.96	157.47
Column 5	12.00	274.00	22.83	287.94

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4426.82	4.00	1106.70	5.08	0.00	2.54
Within Groups	11978.05	55.00	217.78			
Total	16404.87	59.00				

Salmon Creek

Middle Current (cm/sec)

August	Septembe r	October	November	December
6	6.7	15	35.7	18.7
8.7	9	10	32	33
13	7.7	0.3	25.7	34.3
6	4	7.7	18.7	19.7
6	7.7	6.3	34.3	21.3
6	0.3	10	21.3	19.7
34.7	0.7	14.3	15.3	10.7
31.3	2	13.3	18.3	8.3
2.3	16.7	7	30.3	22.7
8	1.3	41.3	44.7	45
9.3	16.3	19	45	33
11.3	12.3	11.7	54	30.3

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	12	142.6	11.88333	105.5797
Column 2	12	84.7	7.058333	33.16083
Column 3	12	155.9	12.99167	102.9663
Column 4	12	375.3	31.275	147.9548
Column 5	12	296.7	24.725	112.7184

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4833.769	4	1208.442	12.02717	4.32E-07	2.539686
Within Groups	5526.18	55	100.476			
Total	10359.95	59				

Salmon Creek

Substrate (numerical representation)

June	July	August	September	October	November	December
4	3	4	6	6	4	5
4	4	4	4	4	6	4
3	6	3	6	3	3	3
		5	3	6	4	4

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	11	3.666667	0.333333
Column 2	3	13	4.333333	2.333333
Column 3	4	16	4	0.666667
Column 4	4	19	4.75	2.25
Column 5	4	19	4.75	2.25
Column 6	4	17	4.25	1.583333
Column 7	4	16	4	0.666667

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.532051	6	0.588675	0.405492	0.866199	2.628319
Within Groups	27.58333	19	1.451754			
Total	31.11538	25				

Salmon Creek

Vegetation Index

June	July	August	September	October	November	December
2.55	3.9	2	2	2.5	1.45	2
3.08	3.1	1.9	1.9	1.36	2	2
1.6	1.6	1.5	1.15	1.15	1.5	2
		2.3	2.5	1.5	2.05	2.2

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	7.23	2.41	0.5623
Column 2	3	8.6	2.866667	1.363333
Column 3	4	7.7	1.925	0.109167
Column 4	4	7.55	1.8875	0.310625
Column 5	4	6.51	1.6275	0.359025
Column 6	4	7	1.75	0.101667
Column 7	4	8.2	2.05	0.01

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.621779	6	0.60363	1.758312	0.161899	2.628319
Within Groups	6.522717	19	0.343301			
Total	10.1445	25				

Salmon Creek

Pool Class Rating

June	July	August	Septembe r	October	November	December
2	2	1	1	1	2	2
3	2	1	1	2	2	1
	2	1	2	1	1	1
		1	1	2	1	1

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	2	5	2.5	0.5
Column 2	3	6	2	0
Column 3	4	4	1	0
Column 4	4	5	1.25	0.25
Column 5	4	6	1.5	0.333333
Column 6	4	6	1.5	0.333333
Column 7	4	5	1.25	0.25

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.24	6	0.706667	3.18	0.026265	2.661302
Within Groups	4	18	0.222222			
Total	8.24	24				

Salmon Creek

pH

June	July	August
6	6	6
7	6	6
6	7	6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	19	6.333333	0.333333
Column 2	3	19	6.333333	0.333333
Column 3	3	18	6	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.222222	2	0.111111	0.5	0.629738	5.143249
Within Groups	1.333333	6	0.222222			
Total	1.555556	8				

Salmon Creek

% Pools

June	July	August	September	October	November	December
5	15	40	15	5	4	10
0	20	30	10	5	3	5
5	30	10	20	10	5	5
		35	10	5	20	20

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	10	3.333333	8.333333
Column 2	3	65	21.66667	58.33333
Column 3	4	115	28.75	172.9167
Column 4	4	55	13.75	22.91667
Column 5	4	25	6.25	6.25
Column 6	4	32	8	64.66667
Column 7	4	40	10	50

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1817.801	6	302.9669	5.312347	0.002292	2.628319
Within Groups	1083.583	19	57.0307			
Total	2901.385	25				

Northrup Creek

Substrate (numerical representation)

June	July	August	September	October	November	December
4	4	2	1	1	2	2
3	3	4	1	1	5	2
1	1	2	1	2	5	5
		2	1	1	1	2

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	8	2.666667	2.333333
Column 2	3	8	2.666667	2.333333
Column 3	4	10	2.5	1
Column 4	4	4	1	0
Column 5	4	5	1.25	0.25
Column 6	4	13	3.25	4.25
Column 7	4	11	2.75	2.25

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16.53205	6	2.755342	1.606696	0.199643	2.628319
Within Groups	32.58333	19	1.714912			
Total	49.11538	25				

Northrup Creek

Vegetation Index

June	July	August	September	October	November	December
2.62	2.25	2.9	2.45	1.55	2	1.57
3.94	3.35	3.1	1.6	1.95	2	2
2.05	2.1	2.02	2.15	2.1	1.55	1.5
		2.04	2.65	2.6	2.1	1.65

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	8.61	2.87	0.9399
Column 2	3	7.7	2.566667	0.465833
Column 3	4	10.06	2.515	0.320367
Column 4	4	8.85	2.2125	0.208958
Column 5	4	8.2	2.05	0.188333
Column 6	4	7.65	1.9125	0.060625
Column 7	4	6.72	1.68	0.049267

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3.636395	6	0.606066	2.175103	0.09146	2.628319
Within Groups	5.294117	19	0.278638			
Total	8.930512	25				

Northrup Creek

pH

June	July	August
6	6	6
6	6	6
6	6	6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	18	6	0
Column 2	3	18	6	0
Column 3	3	18	6	0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0	2	0	65535	#NUM!	5.143249
Within Groups	0	6	0			
Total	0	8				

APPENDIX D: RANKED DATA

Since this project was conducted over several months, certain habitat parameters (e. g., temperature) varied greatly from month to month. To reduce the effects of monthly variance, the data for each month was ranked for these parameters and the ranks were used for stream comparison. Those habitat parameters that had significant differences between sections of the same stream (width, % shaded, and % cover) could not be used for this comparison because of their variability within streams. The following tables are the results of the ranking of that data. For each stream, the data for each monthly parameter was sorted from the lowest value to the highest value and the monthly data for the three streams combined was ranked (Zar 1996). Vegetation Index = [4*(%trees)+ 3*(%shrubs)+2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

Depth Ranks

Sandy June	Rank	Salmon June	Rank	Northrup June	Rank	Sandy July	Rank	Salmon July	Rank	Northrup July	Rank	Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank
17	2	15	1	20	5.5	17	15	4	1	16	11.5	10	1.5	10	1.5	15	10.5
24	10.5	18	3	26	13.5	17	15	6	2	17	15	12	5.5	11	3	21	22
25	12	19	4	29	20	21	23	7	3	18	18.5	12	5.5	12	5.5	22	27
28	17.5	20	5.5	33	25	25	30	9	4.5	18	18.5	14	8.5	12	5.5	22	27
30	21	22	7	33	25	29	41.5	9	4.5	22	25.5	16	12.5	14	8.5	22	27
34	28.5	23	8.5	33	25	31	48.5	10	6	26	33.5	17	14	15	10.5	24	32.5
45	54.5	23	8.5	34	28.5	38	58	11	7	26	33.5	18	15.5	16	12.5	24	32.5
48	60.5	24	10.5	34	28.5	39	60.5	13	8.5	27	36.5	19	18.5	18	15.5	25	35.5
50	66	26	13.5	34	28.5	42	62	13	8.5	27	36.5	19	18.5	19	18.5	26	38.5
50	66	27	15	35	31.5	43	64	15	10	28	38.5	22	27	19	18.5	26	38.5
50	66	28	17.5	36	33.5	43	64	16	11.5	29	41.5	25	35.5	21	22	28	43
50	66	28	17.5	36	33.5	44	66.5	17	15	29	41.5	30	49.5	21	22	28	43
51	69.5	28	17.5	38	38	48	68	17	15	30	45	30	49.5	22	27	28	43
52	71	31	22.5	38	38	50	70.5	20	20.5	30	45	31	55	22	27	30	49.5
53	72	31	22.5	40	43.5	50	70.5	20	20.5	31	48.5	34	63	22	27	30	49.5
54	73	35	31.5	40	43.5	51	73	21	23	31	48.5	38	72	23	31	31	55
55	74	37	35.5	40	43.5	51	73	21	23	32	52	38	72	25	35.5	31	55
57	76	37	35.5	40	43.5	51	73	22	25.5	34	54	38	72	25	35.5	32	59
57	76	38	38	41	47	52	75	23	27	35	55	39	76	27	40	32	59
57	76	39	40	43	51	54	77.5	24	28	37	56	41	82.5	28	43	32	59
58	78.5	40	43.5	43	51	54	77.5	25	30	38	58	42	86	28	43	34	63
58	78.5	40	43.5	44	53	54	77.5	25	30	38	58	43	90.5	29	46	34	63
60	80	42	48.5	46	56.5	54	77.5	26	33.5	39	60.5	43	90.5	30	49.5	34	63
61	81.5	42	48.5	48	60.5	56	80	26	33.5	43	64	45	96.5	30	49.5	35	66.5
63	84	43	51	48	60.5	59	81.5	28	38.5	44	66.5	45	96.5	31	55	35	66.5
66	85	45	54.5	48	60.5	62	84	29	41.5	49	69	45	96.5	31	55	36	68

68	86.5	46	56.5	51	69.5	63	86	30	45	59	81.5	46	99	34	63	37	69.5
68	86.5	48	60.5	61	81.5	63	86	31	48.5	60	83	48	103.5	37	69.5	39	76
72	89	48	60.5	62	83	63	86	32	52	67	89	49	106.5	39	76	39	76
78	90	50	66	70	88	65	88	32	52	68	90	49	106.5	39	76	40	80
												50	108.5	40	80	42	86
												50	108.5	40	80	42	86
												53	110.5	41	82.5	42	86
												53	110.5	42	86	43	90.5
												54	113.5	43	90.5	44	93.5
												54	113.5	44	93.5	47	100.5
												54	113.5	45	96.5	48	103.5
												56	117.5	47	100.5	54	113.5
												59	119	48	103.5	55	116
												65	120	48	103.5	56	117.5

Depth Ranks

Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank	Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank
8	2	7	1	19	30.5	17	14.5	11	1.5	17	14.5	16	10.5	21	22	10	1
12	7.5	10	3	25	44.5	19	22.5	11	1.5	17	14.5	18	13.5	23	29.5	11	2
13	11.5	11	4	26	48.5	20	27	12	3	18	18.5	20	17.5	26	36	12	3
16	18.5	12	7.5	27	52	21	30.5	13	4.5	18	18.5	20	17.5	27	38.5	13	4
17	22	12	7.5	28	54.5	23	36.5	13	4.5	20	27	21	22	29	43	14	5
19	30.5	12	7.5	29	57.5	24	40.5	14	7	20	27	21	22	29	43	15	7.5
19	30.5	12	7.5	29	57.5	25	42.5	14	7	23	36.5	21	22	30	47.5	15	7.5
20	33	12	7.5	30	60.5	26	44.5	14	7	23	36.5	22	26	30	47.5	15	7.5
22	35.5	13	11.5	32	65	27	48.5	15	9.5	27	48.5	22	26	32	52.5	15	7.5
25	44.5	14	13	34	70.5	27	48.5	15	9.5	28	52	23	29.5	34	58.5	16	10.5
25	44.5	15	15.5	35	73.5	27	48.5	16	11.5	30	56	23	29.5	34	58.5	17	12
25	44.5	15	15.5	36	77	27	48.5	16	11.5	30	56	24	32	39	68	18	13.5
26	48.5	15	15.5	37	80.5	29	53.5	17	14.5	32	60.5	25	33.5	40	71	19	15
26	48.5	15	15.5	37	80.5	29	53.5	18	18.5	33	63	26	36	41	74.5	20	17.5
26	48.5	16	18.5	37	80.5	30	56	18	18.5	34	66.5	28	40	41	74.5	20	17.5
27	52	17	22	38	83.5	31	58.5	19	22.5	34	66.5	29	43	42	78	21	22
28	54.5	17	22	39	86	31	58.5	19	22.5	36	73	29	43	42	78	22	26
29	57.5	17	22	39	86	32	60.5	19	22.5	36	73	30	47.5	43	80	23	29.5
30	60.5	17	22	40	88	33	63	20	27	38	77.5	30	47.5	44	81.5	25	33.5
31	62.5	18	26.5	41	89.5	33	63	20	27	40	82.5	32	52.5	45	85	26	36
32	65	18	26.5	42	93	35	70	21	30.5	41	85	33	55.5	45	85	27	38.5
32	65	18	26.5	44	99	37	75.5	22	32.5	41	85	34	58.5	46	89	29	43
33	68	18	26.5	44	99	37	75.5	22	32.5	41	85	34	58.5	46	89	31	50
34	70.5	19	30.5	44	99	38	77.5	23	36.5	43	91	35	61.5	47	91	32	52.5
35	73.5	22	35.5	44	99	39	80	23	36.5	45	94	35	61.5	49	92.5	32	52.5
35	73.5	22	35.5	45	103.5	40	82.5	23	36.5	47	95.5	36	64	50	94.5	33	55.5
35	73.5	22	35.5	45	103.5	42	88	24	40.5	48	97.5	36	64	51	97	36	64
36	77	23	39	46	106.5	42	88	25	42.5	52	100.5	37	66	51	97	39	68
36	77	23	39	48	108	44	93	26	44.5	54	102.5	39	68	52	100	41	74.5
37	80.5	23	39	50	109	47	95.5	27	48.5	55	104	40	71	53	102.5	41	74.5

38	83.5	24	41.5	52	110.5	48	97.5	34	66.5	59	108	40	71	54	105.5	46	89
39	86	24	41.5	52	110.5	51	99	34	66.5	59	108	42	78	54	105.5	49	92.5
42	93	27	52	53	112	52	100.5	35	70	59	108	44	81.5	54	105.5	50	94.5
42	93	29	57.5	56	113	54	102.5	35	70	66	113.5	45	85	54	105.5	53	102.5
43	96	31	62.5	57	114.5	56	105	36	73	66	113.5	45	85	55	108	56	109
44	99	33	68	58	116	57	106	39	80	67	115	45	85	57	111	57	111
45	103.5	33	68	64	117	60	110.5	39	80	68	116	51	97	58	113	59	115
45	103.5	41	89.5	66	118	60	110.5	42	88	71	118	52	100	59	115	59	115
46	106.5	42	93	69	119	61	112	43	91	72	119.5	52	100	64	119.5	60	117
57	114.5	42	93	71	120	69	117	43	91	72	119.5	57	111	64	119.5	62	118

Depth Ranks

Sandy		Salmon		Northrup	
Dec	Rank	Dec	Rank	Dec	Rank
11	1.5	28	39	14	8
11	1.5	30	47.5	16	12
12	3	32	53.5	16	12
13	5	32	53.5	17	14.5
13	5	32	53.5	18	16
13	5	32	53.5	19	17.5
14	8	32	53.5	21	21.5
14	8	34	59.5	21	21.5
15	10	34	59.5	21	21.5
16	12	35	63.5	21	21.5
17	14.5	35	63.5	22	25.5
19	17.5	36	67.5	22	25.5
20	19	37	70	22	25.5
22	25.5	37	70	23	28
26	34	39	72	25	31
28	39	42	76	25	31
29	44.5	42	76	25	31
29	44.5	44	79.5	25	31
31	49.5	44	79.5	25	31
32	53.5	45	82.5	27	35
33	57.5	45	82.5	28	39
35	63.5	46	85.5	28	39
36	67.5	49	88	28	39
37	70	50	90	28	39
45	82.5	50	90	28	39
47	87	50	90	29	44.5
51	93	51	93	29	44.5
52	96	52	96	30	47.5
52	96	53	99	31	49.5
53	99	54	102	33	57.5

53	99	55	104	35	63.5
54	102	56	105.5	35	63.5
54	102	58	108	35	63.5
56	105.5	58	108	40	73.5
58	108	59	110.5	40	73.5
59	110.5	60	113	42	76
60	113	61	115	43	78
60	113	62	116	45	82.5
65	119.5	64	117.5	46	85.5
65	119.5	64	117.5	51	93

Temperature Ranks

Sandy June	Rank	Salmon June	Rank	Northrup June	Rank	Sandy July	Rank	Salmon July	Rank	Northrup July	Rank	Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank
23.9	8	19.5	3	21.5	6.5	22.5	3	23.5	8	23	6	18	10	17	7.5	14	2
24	9	19.3	1.5	21.5	6.5	22.7	4	21.5	1.5	23	6	18	10	17	7.5	15	5
21.3	4.5	19.3	1.5	21.3	4.5	24.4	9	21.5	1.5	23	6	15	5	19	12	14	2
												15	5	18	10	14	2

Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank	Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank
15	3	17	9.5	17	9.5	9	4.5	11	7.5	12	10.5	7	8.5	7	8.5	4	2.5
15	3	17	9.5	17	9.5	9	4.5	11	7.5	12	10.5	7	8.5	7	8.5	4	2.5
15	3	15	3	17	9.5	9	4.5	8	1.5	12	10.5	7	8.5	7	8.5	4	2.5
15	3	16	6	17	9.5	9	4.5	8	1.5	12	10.5	7	8.5	7	8.5	4	2.5

Sandy Dec	Rank	Salmon Dec	Rank	Northrup Dec	Rank
0	7.5	-1	2.5	1	11.5
0	7.5	-1	2.5	1	11.5
0	7.5	-1	2.5	0	7.5
0	7.5	-1	2.5	0	7.5

Middle Current Ranks

Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank	Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank
27.3	16	2.3	1	10	9	19	13	0.3	1	21.3	14	13	8	0.3	1	22.3	15.5
29.7	19.5	6	3.5	17.7	12	24	15	0.7	2	25.7	16	19.3	13	6.3	2	24.7	17
31	22	6	3.5	21.3	13	26.3	17	1.3	3	27	18	22	14	7	3	27.7	18
35.3	27	6	3.5	23.3	14	31.3	21.5	2	4	28.7	19	22.3	15.5	7.7	4	28	19
39	29	6	3.5	24.3	15	36.3	26	4	5	30	20	38.7	23.5	10	5.5	29.7	20
40.3	30	8	6	28.3	17	47	30	6.7	6	31.3	21.5	38.7	23.5	10	5.5	30.7	21
41.7	31	8.7	7	29.3	18	50	31	7.7	7.5	32.7	23	39	25	11.7	7	35.7	22
52	32	9.3	8	29.7	19.5	54	32	7.7	7.5	34	24	44.3	27	13.3	9	46.3	29
59	33.5	11.3	10	30	21	54.3	33	9	9	34.7	25	44.7	28	14.3	10	57.3	32
59	33.5	13	11	32.7	24	54.7	34	12.3	10	37.3	27	48.7	30	15	11	73.3	34
65	35	31.3	23	35	26	55.7	35	16.3	11	38.3	28	53.3	31	19	12	76	35
68.7	36	34.7	25	38	28	59.7	36	16.7	12	40.7	29	66.7	33	41.3	26	76.3	36

Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank	Sandy Dec	Rank	Salmon Dec	Rank	Northrup Dec	Rank
24.3	11	15.3	7	5.7	1	32.7	18	8.3	1	9	2
30.3	15.5	18.3	8	9	2.5	33	20	10.7	3	14	4
32	18.5	18.7	9	9	2.5	34.3	22.5	18.7	9	14.3	5
33.7	20	21.3	10	10.3	4	43	26	19.7	10.5	15	6
40.3	25	25.7	12.5	10.7	5	43.3	27	19.7	10.5	16.3	7
40.7	26.5	30.3	15.5	12.7	6	46.3	29	21.3	13	16.7	8
42.3	28	32	18.5	25.7	12.5	48.3	30	22.7	14	21	12
43	29	34.3	22	30	14	50.3	31	30.3	17	24.7	15
48	32	35.7	23	31.3	17	51	32	33	20	25.3	16
54.3	34	44.7	30	34	21	52.3	33	33	20	41.3	24
72.7	35	45	31	37.3	24	54.3	34	34.3	22.5	42.3	25
88.3	36	54	33	40.7	26.5	57.7	35	45	28	64.7	36

Edge Current Ranks

Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank	Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank
0	3	0	3	0	3	14.3	14.5	0.3	1	7.7	8	0.7	5	0	1.5	11.3	11
1.7	6.5	0	3	5.3	11	14.3	14.5	0.7	2	9.7	10	9	8.5	0	1.5	14.7	15
3.3	8	0	3	8.7	14	15	16	1	3.5	19.7	19	13	14	0.3	3.5	16.7	17.5
6	12.5	1.7	6.5	9.7	16.5	17	17	1	3.5	20.3	20	16	16	0.3	3.5	17	19
16	20.5	3.7	9	15	19	18.3	18	2	5	21	21	16.7	17.5	8	6.5	20.7	21
23	23	4.3	10	16	20.5	27.3	24	4.3	6	24.3	23	19.3	20	8	6.5	21.7	22.5
27	24	6	12.5	21.3	22	29.3	27.5	6.7	7	28	25.5	22.3	26	9	8.5	21.7	22.5
32	25.5	9.7	16.5	32	27	29.3	27.5	8.7	9	28	25.5	26.7	28	9.3	10	22	24.5
33	29	9.7	16.5	32.3	28	33	29	10	11	36	30	27.7	31	12	12	22	24.5
36	30	9.7	16.5	42	32	42.7	31	10.7	12	46	33	27.7	31	12.7	13	27.7	31
38	31	32	25.5	46	33	45	32	12.3	13	56.3	34	33	33	23	27	48	35
51	34	72	36	61	35	67	36	22.3	22	62.3	35	37	34	27	29	49	36

Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank	Sandy Dec	Rank	Salmon Dec	Rank	Northrup Dec	Rank
24	14	0	2	0	2	0	2	0	2	2	5
25	16	2.3	5	0	2	0	2	7	7.5	6.3	6
31	19	6.7	7.5	0.3	4	0.3	4	13	10	7	7.5
38	21	13	10	4	6	16.3	14	15	13	9.7	9
42	23	25	15	6.7	7.5	17.7	16	18.3	17	14	11.5
44	24	27	17	10.3	9	28.3	24.5	24	21	14	11.5
46	26.5	36	20	19.7	11.5	28.3	24.5	24.7	22	17.3	15
47	28	39	22	19.7	11.5	28.7	26	26	23	19.7	18
52	30	45	25	20.3	13	29.3	27	31	30	21.7	19
54	31	50	29	28	18	29.7	28.5	45.3	33	22	20
60	33	56	32	46	26.5	39.7	32	54.7	34	29.7	28.5
63	35	70	36	62.3	34	55.7	35.5	55.7	35.5	33	31

% Pools
Ranks

Sandy June	Rank	Salmon June	Rank	Northrup June	Rank	Sandy July	Rank	Salmon July	Rank	Northrup July	Rank	Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank
25	7	0	1.5	0	1.5	15	2	15	2	20	4.5	5	2	10	4	2	1
40	8	5	3.5	10	5	15	2	20	4.5	30	7.5	10	4	30	8.5	10	4
50	9	5	3.5	20	6	25	6	30	7.5	50	9	20	7	35	10	15	6
												60	12	40	11	30	8.5

Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank	Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank
5	2	10	5.5	5	2	3	1	5	3	10	6	2	1	3	2	10	6
5	2	10	5.5	20	9.5	10	6	5	3	20	9	5	4.5	4	3	20	8.5
10	5.5	15	8	60	11	15	8	5	3	35	11	15	7	5	4.5	30	11
10	5.5	20	9.5	70	12	25	10	10	6	60	12	30	11	20	8.5	30	11

Sandy Dec	Rank	Salmon Dec	Rank	Northrup Dec	Rank
10	4	5	1.5	10	4
15	6	5	1.5	20	7.5
25	9.5	10	4	40	11.5
25	9.5	20	7.5	40	11.5

Pool Class Rating Ranks

Sandy June	Rank	Salmon June	Rank	Northrup June	Rank	Sandy July	Rank	Salmon July	Rank	Northrup July	Rank	Sandy Aug	Rank	Salmon Aug	Rank	Northrup Aug	Rank
1	2.5	2	5.5	2	5.5	1	2.5	2	8.5	1	2.5	1	5.5	1	5.5	1	5.5
1	2.5	3	7	1	2.5	1	2.5	2	8.5	1	2.5	1	5.5	1	5.5	1	5.5
1	2.5					2	8.5	2	8.5	2	8.5	1	5.5	1	5.5	1	5.5
												2	11.5	1	5.5	2	11.5

Sandy Sept	Rank	Salmon Sept	Rank	Northrup Sept	Rank	Sandy Oct	Rank	Salmon Oct	Rank	Northrup Oct	Rank	Sandy Nov	Rank	Salmon Nov	Rank	Northrup Nov	Rank
1	5	1	5	1	5	1	4.5	1	4.5	1	4.5	1	5.5	1	5.5	1	5.5
1	5	1	5	1	5	1	4.5	1	4.5	1	4.5	1	5.5	1	5.5	1	5.5
1	5	1	5	1	5	2	10.5	2	10.5	1	4.5	1	5.5	2	11.5	1	5.5
2	11	2	11	2	11	2	10.5	2	10.5	1	4.5	1	5.5	2	11.5	1	5.5

Sandy Dec	Rank	Salmon Dec	Rank	Northrup Dec	Rank
1	5.5	1	5.5	1	5.5
1	5.5	1	5.5	1	5.5
1	5.5	1	5.5	1	5.5
1	5.5	2	11.5	2	11.5

APPENDIX E: INTER-STREAM ANALYSIS

Since this project was conducted over several months, certain habitat parameters (e. g., temperature) varied greatly from month to month. To reduce the effects of monthly variance, the data for each month was ranked for these parameters and the ranks were used for stream comparison. Those habitat parameters that had significant differences between sections of the same stream (width, % shaded, and % cover) could not be used for this comparison because of their variability within streams. The following tables are the results of inter-stream ANOVAs performed on each of the habitat parameters. Each stream contained two sites that were sampled for analysis, and each of these sites was divided into 5 sections. To differentiate between the sections at the two sites for each stream, the sites have been labelled 'A' for the upstream site and 'B' for the downstream site. Many stream sections were sampled more than once during this project. For those sections that had such sampling repetition, only one of those sampling occurrences was used in this analysis. Numbers (i.e., 1=June, 2=July, etc.) were pulled out of a hat to determine which sampling occurrence was used for analysis at sections that had such repetition. In this way, all of the data for each stream represents the measurement of that parameter during one month only. Vegetation Index = [4*(%trees)+3*(%shrubs)+ 2*(%grass)+ 1*(%bare ground)]; Pools were classified as follows: first class pools (1) were large and deep, providing a low velocity resting area, > 30% of the bottom was obscured by turbulence or structures such as overhanging vegetation, logs, or boulders; in second class pools (2), 5 - 30% of the bottom was obscured; in third class pools (3) cover, if present, was only in the form of shade or turbulence, the bottom of third class pools was almost entirely visible; Primary Substrate types were quantified as follows: silt=1, sand=2, gravel=3, cobble=4, boulders=5, bedrock=6.

	Depth (Ranks)		
Section	Sandy	Salmon	Northrup
1A	44.5	105.5	25
	48.5	91	51
	54.5	85	20
	73.5	100	28.5
	93	89	33.5
	103.5	78	25
	93	74.5	5.5
	96	78	13.5
	77	92.5	33.5
	83.5	111	60.5
1B	81.5	36.5	25.5
	76	66.5	35
	86.5	70	44.5
	90	3	39
	89	7	31
	85	7	31
	86.5	1.5	39
	80	14.5	57.5
	78.5	27	82.5
	76	9.5	93
2A	70	11.5	21.5
	58.5	9.5	8
	60.5	11.5	12
	63	18.5	17.5
	63	7	16
	30.5	22.5	25.5
	22.5	30.5	14.5

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	100.00	6501.00	65.01	886.09
Column 2	100.00	5276.50	52.77	1311.38
Column 3	100.00	6074.50	60.75	1010.85

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7727.02	2.00	3863.51	3.61	0.03	3.03
Within Groups	317622.97	297.00	1069.44			
Total	325349.99	299.00				

min det	16.42		
SE	3.27		
q	3.74	1.30	2.44
q.05,297,3	3.31		

Sandy not= Salmon
Sandy=Northrup
Salmon=Northrup

	44.5	4.5	12
	58.5	4.5	21.5
	95.5	1.5	39
2B	48.5	52	43
	48.5	93	35.5
	53.5	68	68
	53.5	89.5	86
	48.5	93	76
	27	30.5	63
	42.5	41.5	66.5
	36.5	26.5	86
	40.5	26.5	86
	14.5	35.5	103.5
3A	35.5	3	93.5
	103.5	7.5	80
	108.5	22	76
	96.5	18.5	59
	96.5	35.5	69.5
	90.5	7.5	38.5
	72	26.5	117.5
	76	15.5	113.5
	82.5	22	116
	72	7.5	55
3B	97	67.5	59
	52.5	72	49.5
	55.5	79.5	49.5
	29.5	70	55
	43	70	43
	43	82.5	100.5
	85	90	63
	111	76	66.5
	100	85.5	90.5
	100	104	43
4A	26	17.5	115

	26	48.5	102.5
	29.5	48.5	118
	47.5	40	111
	36	35.5	117
	66	31.5	92.5
	61.5	22.5	94.5
	58.5	17.5	115
	61.5	13.5	109
	64	22.5	89
4B	64	68	56
	60.5	74.5	73
	73	97	63
	86	102.5	91
	81.5	105.5	36.5
	77.5	58.5	48.5
	73	94.5	56
	64	105.5	27
	66.5	115	27
	70.5	105.5	18.5
5A	27	99	77.5
	12.5	79.5	97.5
	5.5	96	85
	14	102	85
	1.5	82.5	85
	18.5	113	94
	5.5	93	104
	8.5	115	95.5
	18.5	90	108
	15.5	88	108
5B	102	7.5	43.5
	119.5	13	69.5
	119.5	15.5	31.5
	105.5	22	38
	96	26.5	28.5

	99	39	47
	108	39	43.5
	99	41.5	43.5
	110.5	35.5	56.5
	96	68	60.5
Average	65.01	52.77	60.75

Pool Class Rating (Ranks)

Section	Sandy	Salmon	Northrup
1A	5.5	5.5	8.5
1B	2.5	11	4.5
2A	4.5	5.5	11.5
2B	5	10.5	5.5
3A	4.5	5.5	5
3B	5.5	5	5.5
4A	5.5	8.5	2.5
4B	5	5.5	4.5
5A	5.5	5	5.5
5B	10.5	5.5	5.5
Average	5.4	6.75	5.85

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10.00	54.00	5.40	4.04
Column 2	10.00	67.50	6.75	5.46
Column 3	10.00	58.50	5.85	6.11

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	9.45	2.00	4.73	0.91	0.42	3.35
Within Groups	140.55	27.00	5.21			
Total	150.00	29.00				

min det 3.71

		Substrate	
Section	Sandy	Salmon	Northrup
1A	4	4	2
1B	4	3	5
2A	2	6	2
2B	4	6	2
3A	2	4	1
3B	6	3	2
4A	4	4	3
4B	5	4	1
5A	4	4	2
5B	2	5	1
Average	3.7	4.3	2.1

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10.00	37.00	3.70	1.79
Column 2	10.00	43.00	4.30	1.12
Column 3	10.00	21.00	2.10	1.43

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	25.87	2	12.93	8.93	0.001	3.35
Within Groups	39.10	27	1.45			
Total	64.97	29				

min det	1.96			
SE	0.38			Salmon not = Northrup
q	5.78	4.20	1.58	Sandy not= Northrup
q.05,27,3	3.53			Sandy = Salmon

Middle Current (Ranks)

Section	Sandy	Salmon	Northrup
1A	26	23	2
	31	18.5	6
	34	12.5	7
1B	20	10	16
	25	9	12
	35	3	24
2A	14	6	26
	25	9	19.5
	23.5	7.5	18
2B	28	25	8
	13	23	25
	8	1	36
3A	23.5	10.5	15
	15.5	10.5	14
	30	13	21
3B	36	7	24
	34	8	13
	29	15.5	28
4A	15.5	4	25
	26.5	2	23
	11	5.5	28
4B	16	30	29
	33.5	31	21
	35	33	32
5A	36	5	15.5
	22	7.5	18
	19.5	1	22
5B	32	28	9
	18	20	17
	20	17	12
Average	24.51667	13.2	18.86667

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	30.00	735.50	24.52	67.65
Column 2	30.00	396.00	13.20	90.23
Column 3	30.00	566.00	18.87	67.21

ANOVA

Source of	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between	1921.01	2.00	960.50	12.80	1.34E-05	3.10
Within Gro	6527.51	87.00	75.03			
Total	8448.51	89.00				

min det	7.94		
SE	1.58		
q	7.16	3.57	3.59
q.05,87,3	3.40		

all are not equal

Section	Vegetation Index Sandy	Salmon	Northrup
1A	2	3.9	2
1B	1.2	1.15	2.1
2A	2	2	2.9
2B	2.1	1.5	1.65
3A	1.8	2	3.1
3B	1.75	1.6	2.02
4A	2	3.08	1.6
4B	1.8	2.05	2.6
5A	2	1.9	1.57
5B	1.9	2.2	2.1
Average	1.855	2.138	2.164

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10.00	18.55	1.86	0.07
Column 2	10.00	21.38	2.14	0.64
Column 3	10.00	21.64	2.16	0.29

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.59	2.00	0.29	0.88	0.42	3.35
Within Groups	8.96	27.00	0.33			
Total	9.55	29.00				

min det 0.54

Section	Sandy	pH Salmon	Northrup
1	7	6	6
	6	6	6
	6	6	6
2	7	7	6
	6	6	6
	6	6	6
3	6	6	6
	7	7	6
	6	6	6
Average	6.333333	6.222222	6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	9.00	57.00	6.33	0.25
Column 2	9.00	56.00	6.22	0.19
Column 3	9.00	54.00	6.00	0.00

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.52	2.00	0.26	1.75	0.20	3.40
Within Groups	3.56	24.00	0.15			
Total	4.07	26.00				

min det 0.64

Section	Sandy	% Pools (Ranks) Salmon	Northrup
1A	4	7.5	6
1B	9	9.5	11
2A	6	3	6
2B	2	4	7.5
3A	8	1.5	8.5
3B	7	2	4
4A	1	1.5	11
4B	4	8.5	6
5A	11	5.5	11.5
5B	9.5	10	8.5
Average	6.15	5.3	8

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10.00	61.50	6.15	11.11
Column 2	10.00	53.00	5.30	11.29
Column 3	10.00	80.00	8.00	6.56

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	38.12	2.00	19.06	1.97	0.16	3.35
Within Groups	260.63	27.00	9.65			
Total	298.74	29.00				

min det 5.05

Section	Sandy	Temperature (Ranks) Salmon	Northrup
1A	3	8.5	6.5
1B	4.5	2.5	9.5
2A	4.5	7.5	2.5
2B	8.5	1.5	2.5
3A	3	6	7.5
3B	8.5	7.5	10.5
4A	4	1.5	11.5
4B	9	8.5	2
5A	7.5	8.5	10.5
5B	5	10	2
Average	5.75	6.2	6.5

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10.00	57.50	5.75	5.63
Column 2	10.00	62.00	6.20	10.18
Column 3	10.00	65.00	6.50	15.50

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.85	2.00	1.43	0.14	0.87	3.35
Within Groups	281.73	27.00	10.43			
Total	284.58	29.00				

min det 5.25

Section	Sandy	Edge Current (Ranks) Salmon	Northrup
1A	18	29	7.5
	24	5	9
	14.5	2	11.5
1B	26.5	1.5	13
	24	6.5	34
	33	29	11.5
2A	16	10	32
	33	15	3
	34	7.5	22
2B	16	36	5
	27.5	6.5	31
	32	25.5	19
3A	26	16.5	8
	28	3	21
	31	10	10
3B	30	22	28
	23	7	19
	35	1	16.5
4A	21	13	24.5
	19	3.5	11
	16	12	17.5
4B	34	17	35
	30	22	36
	31	20	24.5
5A	14	3.5	15
	28	9	31
	31	2	19
5B	25.5	30	26.5
	23	33	11.5
	3	21	18
Average	24.9	13.96667	19.01667

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	30.00	747.00	24.90	58.40
Column 2	30.00	419.00	13.97	110.83
Column 3	30.00	570.50	19.02	90.28

ANOVA

Source of	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between	1796.54	2.00	898.27	10.38	9.03E-05	3.10
Within Gro	7525.91	87.00	86.50			
Total	9322.45	89.00				

min det	8.53		
SE	1.70		
q	6.44	3.46	2.97
q.05,87,3	3.40		

Salmon=Northrup
Sandy not= Northrup
Sandy not= Salmon